POWER

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Automatics

By RUFUS T. STROHV

There are scads of strange devices in our power plants today,
Made to put an end to trouble and to keep the jinx away,
While a lot of them are fashioned with the pleasing end in view
Of avoiding heavy labor that would fall to me and you;
But although they're almost human in the way they do their share,
They require close inspection and they need continued care;
So some accidents will happen and some trials will remain,
For we haven't found the fellow with an automatic brain.

You can use a warning whistle of the kind that starts to blow
When the water in the boiler gets too high or falls too low,
But your hair will turn to silver while you wait to hear it wail,
If the water-column piping isn't free from sludge and scale;
And unless the water tender is alive and on the jump,
It will never halt disaster though it blare like Gabriel's trump;
For a boiler can't forevermore withstand an overstrain,
And we haven't found the fellow with an automatic brain.

You may furnish every engine with a form of safety stop,
With the object of protecting all the workers in the shop,
But you've got to clean and oil it, or its joints will rust and grip,
And you'll find it out of order when you're praying it will trip.
So, you see the risks you're running and the chances that you take
If the chief and his assistants aren't keen and wide awake;
Troubles thrive where men are careless, foolish, ignorant or vain,
Since we haven't found the fellow with an automatic brain.

Thus with stokers, lubricators, non-return valves and the like—
They are mighty clever helpers, but they're sure to go on strike
If, when you have made them part of your equipment, you proceed
To forget you ever bought them and ignore the care they need.
You will find that they'll protect you, and your drudgery will shrink,
But they're only brass and iron, and they weren't made to think;
So you needn't look for absolute security to reign
Till the race brings forth the fellow with an automatic brain.

Central-Station Operation in Tropical America

By L. E. GOWLING
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Operating a power plant in the tropics is accomplished under more difficult conditions than those obtaining in colder climates. Three factors affect the general boiler operation—fuel condition, distribution of load and the general condition of the cooling water for the condensers. The condenser problem is the greatest daily factor that has to be contended with, as the temperature of the injection water averages 81.37 degrees. The article deals with some of the operating conditions.

EARLY in 1913 a consolidation of the street railway, lighting and power interests in the City of Havana, Cuba, was carried out, the new organization being known as the Havana Electric Railway, Light and Power Co. To take care of the ever-increasing demand for electric energy and also to reduce the cost of producing power, the new consolidated power plant was designed and built in 1913-14,[1] this plant (see Fig. 1), taking the place of three old and inadequate power stations. The general equipment of this station consisted of three 12,500-kw. Westinghouse turbine-generators, complete with surface condensers and air, condensate, circulating and boiler-feed pumps, all of centrifugal type and steam-turbine driven (see Fig. 2). The boiler equipment consisted of twenty-four 600-hp. B. & W. horizontal water-tube boilers with superheaters; sixteen of these boilers were equipped with stokers but the other eight, not being immediately needed, were left without furnaces. These are now being equipped with furnaces for oil burning. A complete mechanical equipment was also installed to receive coal from ships or lighters at the private wharf of the plant, deliver it to the furnaces, remove the ashes and load them into railroad cars, all without hand labor. Since the beginning of operation of the consolidated power plant in 1914, the increase in production per year has been continuous and rapid; beginning with the

[1]Described in *Power*, Aug. 17, 1915, and Aug. 24, 1915.

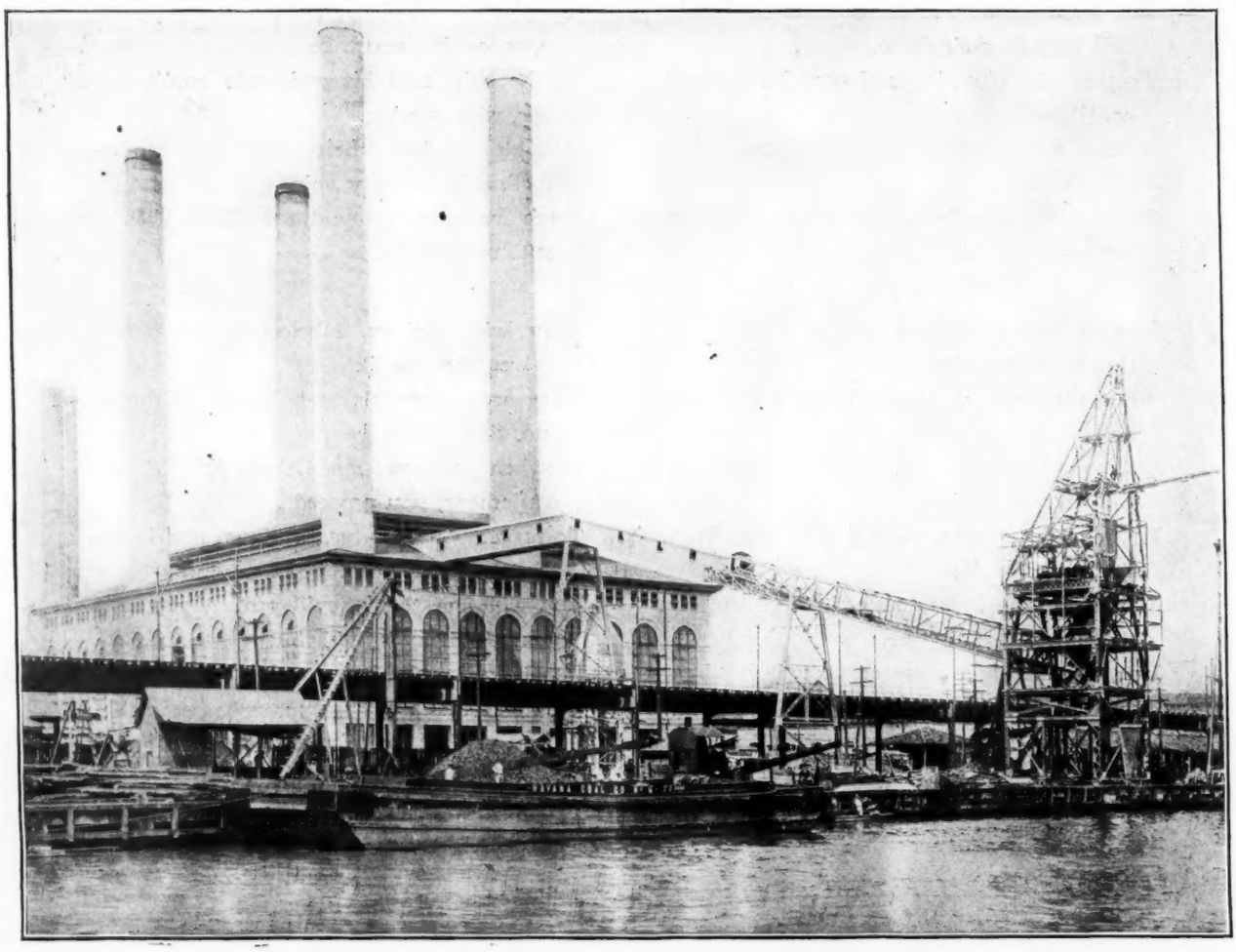

FIG. 1. OUTSIDE VIEW OF THE POWER PLANT OF THE HAVANA ELECTRIC LIGHT AND POWER COMPANY

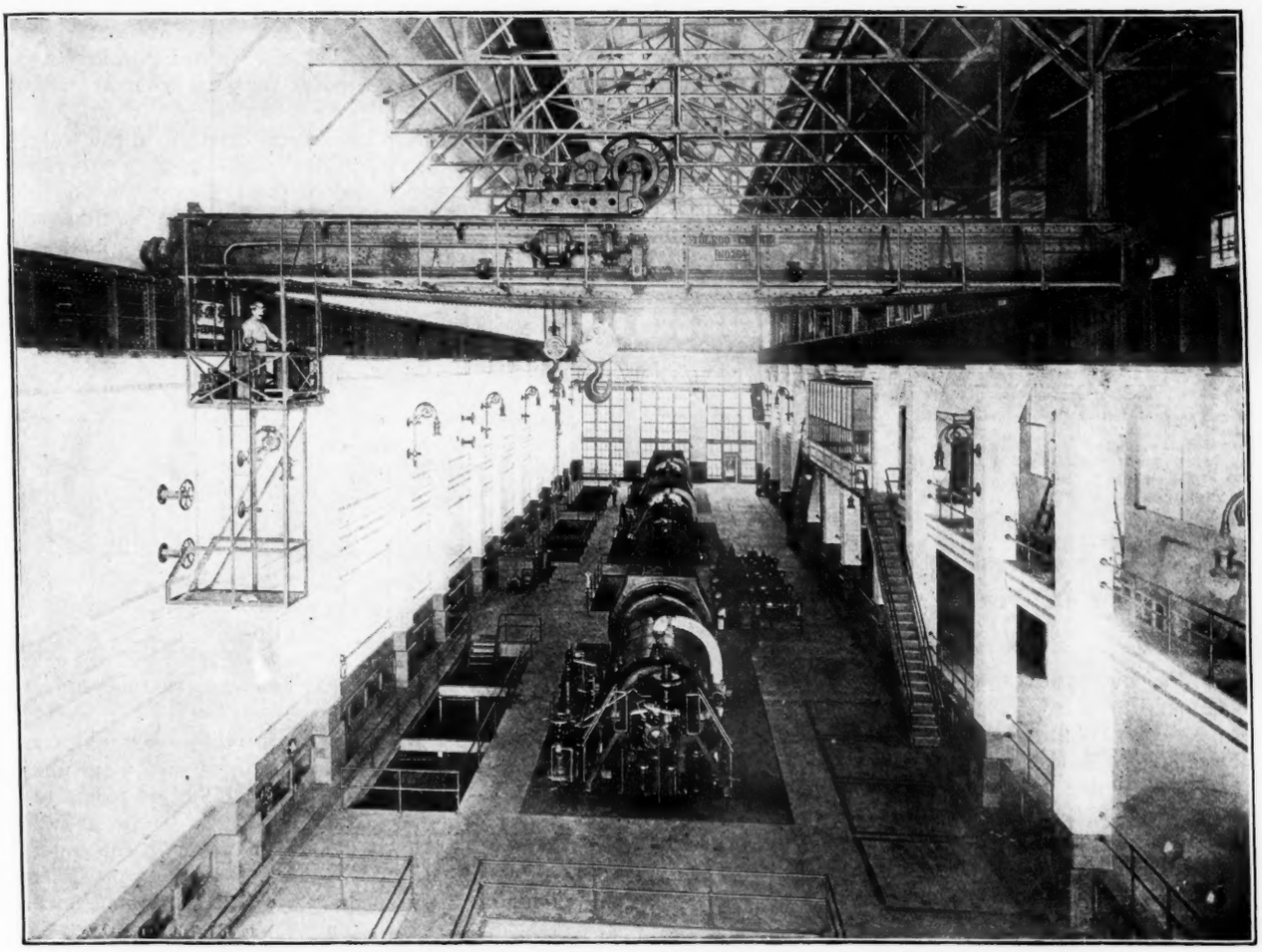

FIG. 2. GENERAL VIEW OF TURBINE ROOM, HAVANA ELECTRIC LIGHT AND POWER COMPANY

current year, however, the increase has far outstripped all previous records. The percentage of increase each year has been as follows: 1915, 6.3 per cent; 1916, 11.2 per cent; 1917, 13.1 per cent; 1918, 7.8 per cent; 1919, 13 per cent; 1919, first six months, 8.5 per cent; 1920, first six months, 23.1 per cent. The curves Figs. 3, 4 and 5 show very clearly the growth of load over the various years.

In operating a central power station in the Tropics, on account of the climatic and living conditions, a somewhat larger labor force is necessary to handle the same amount of equipment; it is necessary that much larger stocks of materials and replacement parts be kept on hand because of delays in shipment and transport; and the cost of all materials is enormously increased. All this tends to increase the cost of energy per kilowatt-hour at the switchboard and to the consumer.

Because of the high importation charges it has been the policy of the company to purchase only the best obtainable grade of coal, but during the late war and up to the present time, it has been very difficult to get selected fuel. The semi-bituminous coal that is being used at present contains about 13,000 B.t.u. per pound, and represents 81 per cent of the total cost of manufacture per kilowatt-hour generated.

Every effort has been made to maintain a high standard of operation in the plant, and the operating efficiencies obtained since the equipment was placed in service have varied but slightly. The cost of energy generated, however, has risen, owing to large increases in fuel, material and labor charges.

The plant supplies current for the operation of the electric railway and the electric light and power service of the City of Havana. The generators operate at 2,300 volts three-phase 60-cycles, at which a portion of the output is distributed to both services. A part of the light and power distribution (underground) is at 6,000 volts, and energy for all the railway substations but one and part of the light and power distribution is transmitted at 13,200 volts.

The three factors having the greatest effect on the general boiler operation in this plant are conditions of fuel, distribution of load and general condition of cooling water for the condensers. The average rating of the operating boilers, based on active hours, is 161.25 per cent with feed water at 214 deg. F.; three boilers only are used on the midnight to morning load, six to handle the day load, and ten to carry the peak, which is very steady. Practically none of the commercial power load extends beyond the daylight hours, and the resultant daily load factor is kept down in consequence. The condition of the circulating water, the effect of which will be described more fully, makes it necessary to maintain at all times a large percentage of banked boilers ready for service, even during the peak hours. About 5.2 per cent of the total coal consumed daily is utilized solely for this insurance of service.

Some general figures given for the average operation of the plant for the first four months of the present year are as follows:

During a series of check runs on the average daily operation last fall, a boiler and furnace efficiency of

79.5 per cent was obtained, with a corresponding coal rate of 1.55 lb. per kw.-hr. generated, the flue gas averaging at the same time about 13 to 13.5 per cent CO_2. This check covered an eight-hour period including the peak.

The condenser problem is the greatest factor in the daily operation that has to be contended with in Havana. The average temperature of injection water for January to May, 1920, was 76.77 deg. F., and the average vacuum obtainable was 27.96 in. referred to 30-in. barometer. In the year 1919 the maximum temperature was 86.40 deg. F., the minimum 72.02 deg. and the average 81.37 deg. The circulating water is obtained from an arm of the local harbor and is a mixture of salt water, a small amount of fresh water from streams and stormwater from drains emptying into the harbor.

Average hourly production, kw.-hr	8,440
Average daily maximum hourly production, kw.-hr	17,515
Load factor (daily), per cent	48.19
Based on: Average production kw.-hr. / Average daily maximum production kw.-hr.	
Plant factor, per cent	22.5
Based on: Average production, kw.-hr. / Installed station capacity for continuous rating	
Boiler steam pressure, lb. gage	200
Average superheat, deg. F	150
Net evaporation—actual	8.42 lb. per lb. coal
Evaporation (from and at 212 deg. F.)	9.52 lb. per lb. coal

Note: Evaporation is corrected for water blowdown and steam used in jets under the grates.

Coal rate	2.121 lb. per kw.-hr. generated
Coal rate	2.135 lb. per kw.-hr. distributed
Boiler and furnace efficiency	72.46 per cent., monthly maximum
Boiler and furnace efficiency	71.00 per cent., monthly average
Net plant efficiency	12.4 per cent

Note: Efficiencies based on assumed average calorific value of coal, 13,000 B.t.u.

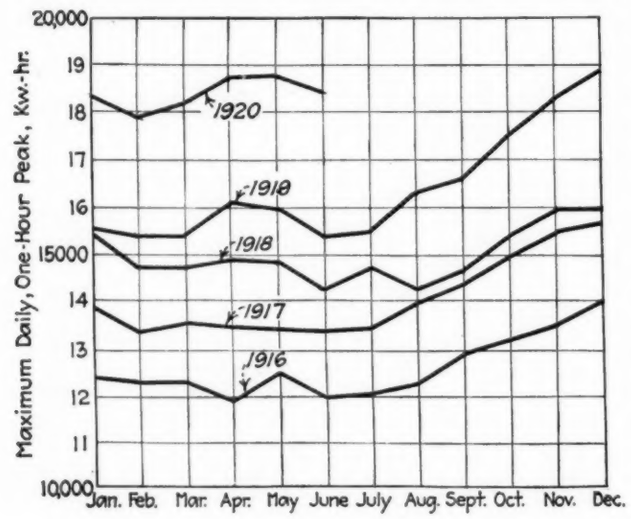

FIG. 3. MAXIMUM DAILY ONE HOUR PEAK IN KILOWATT-HOURS

It carries a considerable amount of salt, some sewage, abundant jellyfish and other animal matter. During the summer months especially, when the water temperature is high, a great deal of very sticky matter is carried in suspension. In fact, this coating on the condenser tubes reduces their heat-transmitting capacity quite seriously and makes it substantially impossible to maintain the cooling surface at high efficiency. This deposit is easily removed, however, by washing with a rotating brush and a stream of water. Most of the condenser fouling comes from the large amount of silt and animal life in the water, and condenser tubes are cleaned with compressed air and water at least every three days and sometimes oftener, in order to keep the vacuum as high as is necessary for good economy of the main turbine units.

Among the different organisms existing in the water are free-swimming barnacles small enough to pass through the screens; they deposit themselves on the walls of the canal in the plant and at certain times of the year break away in masses; this substance is swept into the condenser and stops up the tubes very quickly and sometimes makes it necessary to remove a turbine unit from service at once. The trouble is overcome to some extent by running all the circulating pumps at full speed, circulating a large amount of water in the canal and loosening up the large masses as much as possible. This is done during the period of light load about once a week.

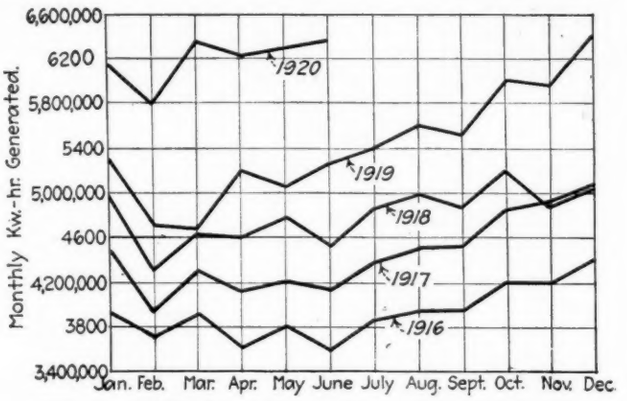

FIG. 4. MONTHLY KILOWATT-HOURS GENERATED

The corrosive action of the cooling water due to its high temperature and impurities is usually severe, and this company was one of the first to make use of the idea of tilting the condensers so that the tubes might drain empty when not in use. This idea was previously worked out in one of the old plants of the company, and the results obtained have fully justified its adoption.

Water for makeup and general plant service is taken from the city water system; it is scarce, high-priced and heavily charged with scale-forming matter. For this reason it is important that all condensate be saved, and the exhaust piping system has been so arranged that any steam not condensed in the heaters is passed to the low-pressure stages of the main turbines, through constant-pressure valves; thus it is made to do useful work and the condensate is saved for boiler feed. As the city supply is subject to variations of pressure and even occasional interruptions seriously threatening the constancy of service, a large fresh-water storage is of great importance and about a fifteen-day supply is kept on the plant property in the combined underground storage system.

A regular maintenance schedule is followed out as closely as is practicable with regard to the boilers, main units, auxiliaries and appurtenances about the plant. Regular and thorough inspections are made every year of each main unit, both the steam and electrical ends, and of all the auxiliaries pertaining to that unit; boilers are cleaned and inspected on regular schedule of working hours, and everything is done to keep the equipment, steam and electrical, in as good condition as possible. Only by this means has it been possible to maintain the plant economically.

It is an interesting fact that the plant was in its sixth year of operation before the first boiler tube was lost, and out of three condensers containing 6,700 tubes each, only 14 have been plugged to the present time, and these showed only slight pinhole corrosion.

Owing to the close proximity of the plant to the ocean and the general humidity and saltiness of the air, particular care has to be taken of the electrical equipment.

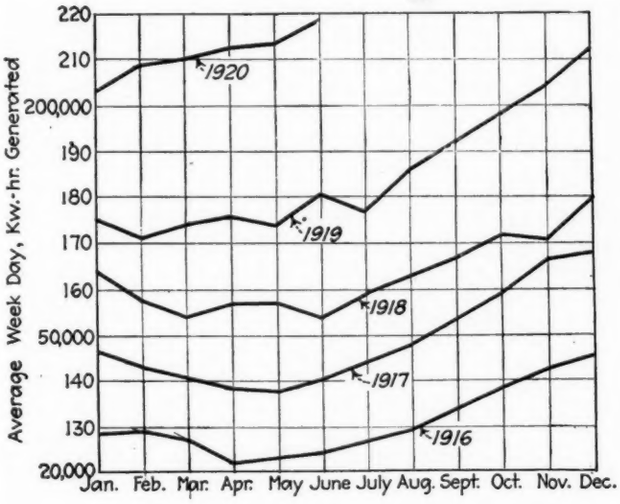

FIG. 5. AVERAGE WEEKDAY KILOWATT-HOURS GENERATED

It is very advisable to keep all electrical apparatus in operation as regularly as possible in order to prevent saturation of the coils; the dampness at night, especially at certain periods of the year, is intense, and at times of sudden changes in temperature the condensation on unused machinery is excessive. Much difficulty is experienced in maintaining switching and other contacts in perfect condition.

The following data on air conditions were obtained during daylight periods only:

Relative Humidity	Nov. 19-Dec. 12, 1919 Deg. F.	June 11-19, 1920, Deg. F.
Maximum	91.0	79.0
Minimum	53.0	58.0
Average	73.0	70.0
Dew Point		
Maximum	74.62	75.46
Minimum	56.75	65.88
Average	66.45	70.39

With the cost of coal mounting year by year, it was thought advisable to make a trial of oil fuel and at the present time the eight boilers which were left without stokers at the time of plant construction are being equipped with furnaces for oil burning. The high setting of these boilers with their front headers 12 ft. above the floor, which at the time of installation was much criticized, should be especially advantageous for burning the new fuel.

Provision is being made to receive oil (Mexican crude) by both water and rail, and storage is being provided on the plant property in underground concrete tanks of such capacity as to furnish fuel for the plant equal to the present coal-bunker supply. With oil as fuel even greater economies of operation and lower energy cost are expected, than obtained with coal.

In view of the future demand for energy an order has recently been placed for two 25,000-kw. three-phase 60-cycle 13,200-volt turbine-generator units with two 56,000-sq.ft. LeBlanc condensers. The new equipment will be installed in the present building with very few changes and in the same manner as previous apparatus was installed.

The condensers will be arranged with divided water boxes so that they can be cleaned while in service, as each condenser is served by two circulating pumps. The turbine will be nozzled to give the best economy between 20,000 and 25,000 kw., and with the new equipment considerable improvement in station efficiency is expected.

A High-Speed Internal-Combustion Engine

H. R. Ricardo, in a paper before the Gas Explosion Section of the British association, as reported in *Engineering*, gave the results of an extended series of tests on a high-speed engine with varying compressions.

A series of the tests dealt with the efficiencies at various loads and with different compression ratios. The results appear in the table. It will be observed that the efficiency at full load was higher with the higher compression ratio; of additional interest are the tests at partial loads, where the efficiencies at the higher compressions show a smaller drop than when using lower compressions.

RESULTS OF THE TESTS

Per Cent of Full Load	Indicated Thermal Efficiency	Brake Thermal Efficiency	Relative Efficiency
	Compression ratio 6 : 1		
Per Cent	Per Cent	Per Cent	Per Cent
100	34.9	30.7	68.2
80	33.	27.5	64.5
60	31.0	25.6	60.6
50	30.0	23.9	58.6
40	....	21.5	....
	Compression ratio 4 : 1		
100	27.5	23.4	64.6
80	25.8	21.7	60.6
60	23.5	19.0	55.3
50	22.3	17.4	52.4
40	....	15.2	....

Experiments with different fuels proved, as might have been expected, that each fuel had a certain limiting and very defined compression, after which detonation occurred, followed by preignition and loss of power. In certain oils no detonation occurred; violent preignition and an excessive drop in speed were the first indications that the compression had been caried too high. In all the ordinary fuels preignition never occurred until the engine had passed through the detonation phase.

The general conclusions arrived at may be summed up as follows:

1. The limiting compression is controlled by the tendency to detonate, which in turn is governed by the normal rate of burning. If means are employed for slowing down the normal rate of burning, such as the addition of a small quantity of CO_2, much higher compression ratios can be employed. Preignition which controls and limits the compression ratio, is in nearly every case brought about by some local use of temperature due to persistent detonation.

2. For any given fuel the tendency to detonate depends, apart from the compression ratio, upon the form of combustion chamber, the number and position of the igniters, the inlet temperature of the mixture, the strength of the mixture and the degree of turbulence.

Operation of Synchronous Motor-Generator Frequency Changers

Uses and Applications—Synchronizing and Paralleling Methods—Explanation of Phase Displacement, Angular Lag and Load Division

By M. W. SMITH
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IT IS often desirable to change the voltage, phase relation and frequency of power generated on one system for use in another system and for various other reasons. The change of voltage or phase relation may be effected by transformers, but the change of frequency must be accomplished by some form of rotating machinery such as the frequency changer, Fig. 1, or its equivalent. A frequency changer generally consists of two synchronous machines directly connected together, built to operate at the same speed but generating different frequencies; consequently they must have a different number of poles.

The frequency changer may be employed to supply power at a different frequency to subsidiary systems having no other source of power or to link together two independent systems each having its own generating plant. In the former case there are no complications introduced as to synchronizing on both ends, etc., since the set has to be synchronized on one end only. The sole requirement between the relation of the motor and generator is to have the correct ratio of field poles to give the desired change in frequency.

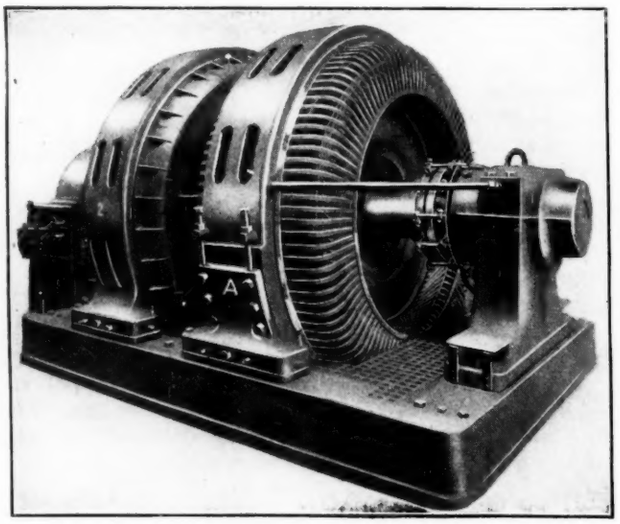


FIG. 1. FREQUENCY-CHANGER SET

There may be various reasons for linking together two independent systems. Where two stations generating power at different frequencies and having their peak loads at different times are close together, there is a mutual economical advantage to be gained in connecting the two systems together by frequency changers, and the efficiency of both plants is materially increased. The frequency changer set is also very valuable when a lighting system generating at 60 cycles is to supply a railway load operating at 25 cycles or in case a railway system is to supply a lighting system. With the increasing use of the single-phase railway motor the frequency changer has been employed as a phase converter as well as a frequency changer by using a three-phase motor and a single-phase generator. By this method the three-phase system is not unbalanced by the single-phase load.

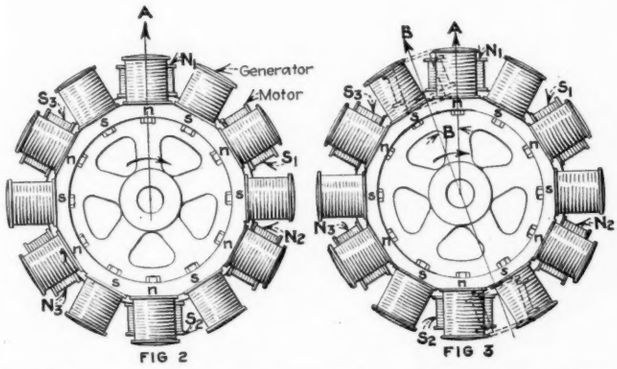
In connection with the foregoing applications the frequency changer has the advantage that by means of a voltage regulator the voltage on the receiving side may be kept constant, within certain limits, regardless of the fluctuations on the motor side of the system. Furthermore, especially in the case of railway work, a load of low power factor on the receiving side has no effect on the power factor of the generating and transmission system.

It is hardly necessary to discuss very fully the methods of starting frequency changers. These have often been explained in connection with synchronous motors. Frequency changers may be started as induction motors by the application of low voltage, usually one-half voltage, on its terminals. This method has the advantage that it requires no synchronizing as the term is generally applied. When the set has reached nearly synchronous speed, the field may be applied and should be overexcited so that when the motor is thrown on full voltage the field will be strong enough to hold the line current down to a reasonably low value. In cases where the line current is excessively high on starting, especially in the case of large sets, or in installations where the generating plant is not very large as compared with the set, it may be necessary to use oil pressure in the bearings.

Where only one set is to be used between two systems, there is no required mechanical relation between the motor and generator, as explained later, and the set is simply synchronized as two machines in the usual way, the motor being synchronized first and then the generator. However, if several sets are to be operated in parallel between two systems, a different problem is encountered. When one set is brought up to speed and synchronized on the motor side with another set, the generator end may not be in phase with the generator bus. This condition is dependent upon the ratio of the number of poles on the motor to the number of poles on the generator. If an unloaded set is being paralleled with busses to which loaded machines are attached, the generator end of the unloaded set can never be in phase with the loaded bus after the motor ends have been thrown together on account of the phase displacement, due to the load.

For the present purpose consideration will be made of unloaded sets. In any case, where the ratio of the poles on the generator to those on the motor is a whole

number, the motor and generator of the set must necessarily be in phase. In fact, every one of the north poles on the motor is directly in line with a north pole on the generator, as shown in Fig. 2, so that no matter at what point the motor is thrown in with respect to the motor of the other set, the relation of the generator will be corrected. But when the ratio of the poles on the generator to those on the motor is other than a whole number, the generator will not necessarily be in proper



FIGS. 2 AND 3. A SIX-POLE AND A TWELVE-POLE ROTOR. RATIO BETWEEN MOTOR POLES AND GENERATOR POLES A WHOLE NUMBER

phase at the same time the motor is thrown in. For instance, consider sets connecting together a 25-cycle and a 60-cycle system, these being the standard frequencies in the United States. Suppose at present the motor is on the 25-cycle side, then the smallest number of poles that can be used to give the desired change in frequency is 10 on the motor and 24 on the generator. This gives a speed of 300 r.p.m., which is usually lower than desirable but as high as possible.

In Fig. 4 is shown the relation of the poles on the motor and generator of such a set. Referring to this figure, it will be seen that there are but two poles on the motor which are exactly in line with the poles on the generator; that is, there are only one-fifth of the poles on the motor in line with poles on the generator. Hence there is only one chance in five of the generator potential being in phase with the busbars when the motor is thrown on. In other words, each pole on the motor corresponds to 2.4 poles on the generator, which is equivalent to one complete cycle and 72 deg. additional, or one cycle on the motor is equivalent to 2.4 cycles on the generator. Therefore, five cycles will have to be made on the motor before an integral number of cycles are made on the generator, which is 5×2.4 cycles $= 12$ cycles. But 5 cycles on the motor, or 12 on the generator, is one revolution of the set. Hence there is only one chance in five of both the motor and generator having the correct phase relation.

Synchronoscopes, phasing lamps or voltmeters may be used to determine whether the generator has the correct phase relation after the motor has been thrown on. If correct, the generator switch is closed. If incorrect, two methods may be resorted to in order to secure the correct relation.

One method is to make use of a special synchronism indicator with two pointers appearing on the same dial, which is a combination of the 60-cycle and 25-cycle indicators. After the 25-cycle end is started and thrown on the line, there is, as stated before, one chance in five of the 60-cycle end being correct for connecting in parallel with the other sets. It is always best to start from the low-frequency side, as there is a better probability of both ends being correct for paralleling than when started from the high-frequency side. The position of the 60-cycle pointer on the indicator will show whether the phase relation is correct. When incorrect, the switch on the motor side is opened and the set begins to slow down. The two pointers on the synchronous indicator begin to revolve at different speeds, the 60-cycle pointer making 2.4 revolutions while the 25-cycle pointer makes one. There will be one instant when both hands will appear together at the top of the dial. However, in the case of an unloaded machine being paralleled with a loaded set, the pointers will not come together at the top of the dial but one will be shifted ahead, since the phase angle, due to the load on the other machines, holds them back in angular phase. Whenever these hands or pointers appear together as mentioned, both machines have the proper phase relation, and at this instant the switch on one machine may be closed and the other machine must necessarily have the correct phase relation, and as soon as its switch is closed the set is in parallel with the others.

In the second method of starting the motor is left connected to the line and a double-pole, double-throw reversing switch is used in the synchronous-motor field to step the motor back (by reversing the field) one pole at a time until the generator has the correct phase relation. Since it is purely a matter of chance and there is only one chance in five of obtaining correct relations,

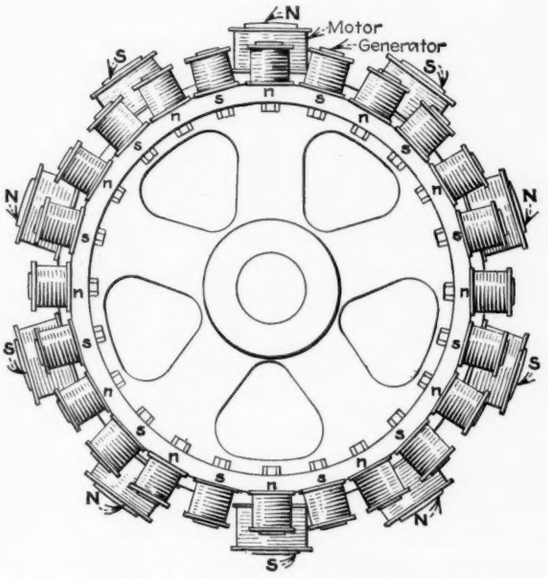


FIG. 4. A TEN-POLE AND A TWENTY-FOUR-POLE ROTOR. ONLY TWO POLES ON MOTOR ARE IN LINE WITH GENERATOR POLES

it may be necessary to reverse the field several times in succession; in the worst case it will be necessary to reverse the motor field four times.

As mentioned previously, an unloaded set can never be in phase with a loaded set, owing to the phase displacement or angular lag caused by the load. This lag angle is due to both the motor and the generator. Since in a synchronous motor the mechanically revolving field must make the same number of revolutions per minute (although a lag angle may exist between them!) as the revolving magnetic field, their relative positions

may be examined by the use of a diagram at rest with the same accuracy as if the diagram were revolving at the given synchronous speed. In other words, the point of view will remain fixed with respect to the magnetic field. At no load (neglecting friction, etc.), the magnetic and mechanical fields are in phase. In Figs. 2 and 3 suppose A to be the point of view and remaining stationary, together with the magnetic field, and let N_1, S_1, N_2, S_2, etc., represent the motor poles and n, s, n, s, etc., represent the poles of the generator. Now when a load is thrown on, the mechanical field of the motor must fall back or lag a certain angle B, as shown in Fig. 3, by the poles drawn in dotted lines, so that it may be able to carry the load. The magnitude or number of degrees in this angle will depend on the load, field excitation and number of poles.

Factors Influencing Lag Angle

Of course, the greater the load the greater must be the lag angle in order to draw larger current from the line to carry the increased load. Since the field excitation fixes the relation between the counter and applied voltages, it must also have some bearing on this angle. If the motor is coupled to a generator having twice the number of poles as itself, the generator will have a lag angle of twice as many electrical degrees as the motor, since the mechanical lag, so to speak, is the same. Take, for instance, the 6-pole motor and the 12-pole generator, as shown in Fig. 2, and, say, a lag angle of 5 deg. (mechanical), there will be a displacement of 15 electrical degrees on the motor and 30 on the generator. The electrical and mechanical design will, of course, also influence this angle, as mentioned later. However, the load is the controlling factor, and, roughly speaking, this angle may be said to be proportional to the load.

In addition to the aforementioned angle there is a further displacement in the angle between a loaded and an unloaded set due to the phase displacement between the induced emf. and terminal emf. of the generator. Every generator must have a certain amount of resistance and inductance in its windings, and when current flows through these windings of the generator, there must be a voltage drop due to this resistance and inductance. The inductive drop is the principal factor which causes the phase displacement. Since the inductance in a machine is practically constant, the inductive drop is proportional to the load, and hence the angular displacement between the induced and terminal voltage of the generator is roughly proportional to the load. A combination of these two actions of phase displacement gives a total displacement (which is roughly proportional to the load) between a loaded and unloaded machine which is equivalent to the sum of the two angles.

Paralleling Frequency-Changer Sets

Obviously, on account of this angular lag an unloaded set can never be exactly in phase with a loaded set, and they must, therefore, be thrown together with this angular displacement between them. Since the emf. of the unloaded set is, therefore, ahead of or in advance of that of the loaded set, it will tend to take the load when the sets are thrown together. However, when some of the load is transformed from the loaded to the unloaded, the lag angle will decrease on the loaded machine and increase on the unloaded machine and the two machines will settle to a stable position, each having the same angular displacement. In some cases where the throwing on of a machine in the manner mentioned causes too much disturbance on the line, the incoming machine may be loaded by water rheostat or other convenient means so as to give it a lag angle corresponding to that of the loaded set in service. A reactance may also be used in the circuit of the incoming machine to limit the initial rush of current. The reactance may be gradually cut out and load transferred to the incoming set.

The load division between sets evidently must depend on the phase angle in each. If any set has a terminal emf. ahead of another set, it will tend to take the load. Two identical sets each having the same field excitation will divide the load equally, but if either set has a motor or a generator with a better or closer regulation than that of the other set, it will take more than its share of the load because (at the same load) its terminal emf. is ahead of the other machines. This machine will continue to take increased load until the increased current in its windings causes its angular lag to equal that of the other machines. Some changes in load division may be effected by field excitation, but this method is not advisable since it must be done at a sacrifice of high power factor, which in many cases defeats one of the main advantages of a synchronous frequency-changer set.

Stator Set in Cradle Structure

The foregoing discussion has been based on the assumption that the mechanical details were perfect; that is, that the motor and generator were lined up exactly. However, owing to the liability of errors in workmanship and machining, this is seldom if ever the case, and there may be an initial phase displacement even at no-load due to mechanical construction. A machine might easily have such a mechanical error of alignment that its action might be reversed at light loads. In view of the fact that such mechanical error is likely to exist even with the most careful construction, the stators of frequency changers which are to be operated in parallel with other sets are mounted in a cradle construction (shown at A, Fig. 1) bolted to the bedplate so that the stator of one machine of the set may be shifted with respect to the rotor and also the stator of the other machine in the set. After the cradle is once set correctly, it is not necessary to change its position for future parallel operation with most frequency-changer sets.

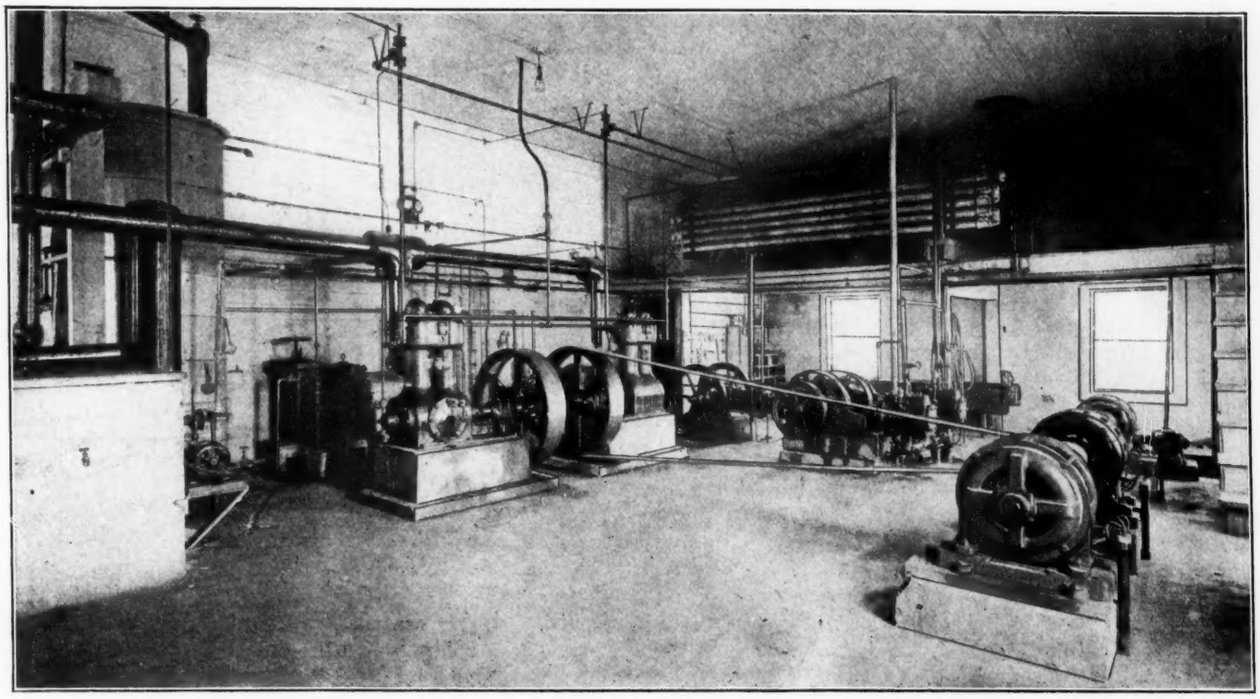
Special cradle construction may be used to shift load from one set to another by shifting the cradle so as to cause the terminal emf. of the one on which the load is to be shifted to lead the terminal emf. of the other machine. Such construction, however, is expensive and undesirable, and is seldom used. This cradle construction is not applicable on a single set connecting together two systems, since there is no fixed phase relation that must exist as between sets in parallel. The rocking of this cradle cannot be used, as sometimes thought, to regulate the energy flow between two systems. The amount and direction of energy flow can be controlled only by the regulation of the prime movers. The energy must flow from the system whose prime movers have the greater driving torque to the other system, since the emf. on that side will be in angular advance of that on the other system.

Behavior of Ammonia in Refrigerating Plants

By JOHN H. RYAN

How to calculate the quantity of ammonia required in a new plant is available in most handbooks, but to find the quantity necessary to add to the charge of a running plant is quite another matter. The author tells how he does it.

THE amount of ammonia required in a new plant varies greatly with the type of plant. A brine-circulating refrigerating plant in which the compressor, condenser, receiver and brine cooler are close together, with short connecting pipes, requires only ten pounds of ammonia per ton of refrigerating capacity. A plant in which the cooling is done by direct-expansion ammonia piping in the rooms often requires as much as fifty pounds per ton of capacity, and if the coils are not defrosted occasionally, a large quantity will lie along on the bottoms of the pipes and slowly boil out. A direct-expansion ice plant requires from twenty to seventy pounds of ammonia per ton of daily ice capacity, depending on its type. An ice plant with top expansion to the tank coils and no unnecessary frills requires even less.



MACHINE ROOM OF A 10-TON IMPROVED RAW-WATER ICE PLANT USING ELECTRICALLY DRIVEN, INCLOSED-TYPE COMPRESSORS

I know a plant of fifty tons capacity in Pennsylvania that worked and defied competition until its owner died, and when we got control of it we found that seven hundred pounds of ammonia gave it a sufficient working charge. It took us a few years to realize how good the old plant was, and in the meantime we had built "hyphenated" plants with different suction pressures, flooded condensers, liquid coolers and regenerators, flooded expansion coils with accumulators and traps, until we required over two hundred pounds of ammonia per ton of ice capacity.

It is usually in the smaller plants that trouble is encountered from too much ammonia in the system. To illustrate the importance of defrosting the coils, an incident in a candy factory is characteristic. The compressor was hitched to a large surface of direct-expansion piping and run day and night. New rooms were piped and connected in. There was a gage glass on the receiver, and the engineer put in ammonia from time to time to keep the liquid showing about one-third full in the glass. The right-hand compressor crankpin worked loose, and when cool weather came the machine was shut down a few days while a new pin was put in. The engineer wanted to do some work on the low side and pumped down while the compressor was running slow, trying out the new crankpin. The water was running through the condensers all right, so the engineer went out in the factory to pack some of the expansion-valve stuffing boxes. He heard some commotion and soon found that the ammonia had driven out a number of people. A fitting had burst on the ammonia condensers and killed two horses hitched to a coal wagon delivering to the plant.

The candy man made a claim for damages, alleging defective material, and I was sent to put on the new fitting and make a report. This was in Massachusetts. The engineer was young, was sure of his facts and presented them like a lawyer. He had a record of the water temperature for the day and the amount being used per minute. The speed of the machine was slow and there was evidence that the "king" valve

on top of the receiver was shut. The pressure was equal on the high and low sides at 90 lb. when he started the compressor. It had pumped down to 45 lb. on the low side in a few minutes. He had no recollection of what the high-side pressure was when he went out, but it must have shown all right on the gage for he would have noticed it if wrong. He had a number of valves to pack that were ordinarily under high pressure, and as he was going to oil them only and put another ring in each, the low pressure on them was safe. He assumed that if the packing did blow out of one, it would be only a few minutes until the compressor would pull the pressure down and enable him to get the packing back.

The broken fitting did not show any flaw; it was slightly rusty from water that had been played on it and it was divided in two. The engineer laid emphasis on the poor weld of the fitting and right then I "got his number." He still had to get his common-sense engineering. I got at the cause of the trouble when he claimed that the fitting let go at comparatively low pressure, because all the noise he heard was what he thought was the fireman blowing down the boiler.

Liquid Ammonia Being Discharged

The sound of a boiler blowing out water is characteristic, is soon recognized and not likely to be mistaken for any other noise. This showed me that liquid ammonia was being discharged to the atmosphere at the time of the break. They were positive that the valves between the condensers and receiver were open and that the anhydrous showed nearly a glass full while the machine was being repaired. I made plain to him how the liquid would lie in the heavily frosted coils, that the frost melted off while the machine was shut down and that when he started it the bare pipe allowed the ammonia in it to get heat and boiled out rapidly. When the receiver was full, the liquid ammonia had to store up in the condenser until something had to let go. He saw the point and went to the office with me, where we got an order for a larger receiver.

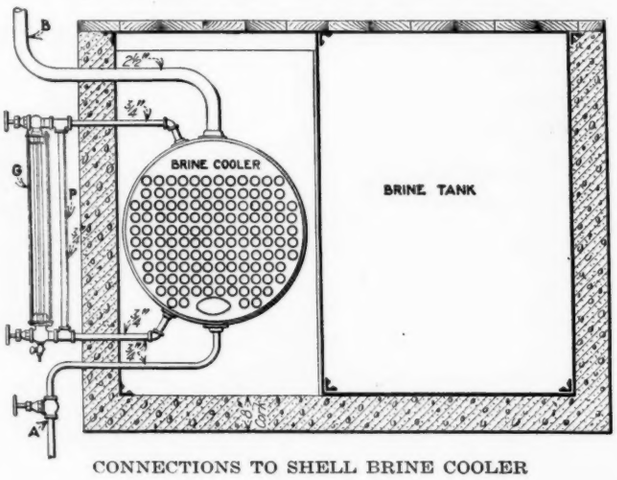
When a Plant Needs Ammonia

To tell when a plant needs ammonia we are informed that the back pressure will fall and the capacity fall off as the charge runs out. A gage glass on the receiver will show the amount in reserve, but the majority of small plants do not have gage glasses so placed, and the engineer guesses the amount. The falling back pressure is not quickly enough noticed as the wider opening of the expansion valve will hold up the back pressure until the charge is small. My method of regulating the charge in all plants is the same. Years ago I acquired the habit of firmly grasping the liquid pipe on the high side of the expansion valve every time I passed by. I made it just as much a part of the regular routine as feeling the compressor rods for packing and oil condition. If there is enough ammonia in the system, the liquid pipe will be cooler to the touch than that of the condensing water leaving the ammonia condensers. The solid stream of ammonia in the liquid pipe has a characteristic "feel" the same as you get from a water pipe in which the water is in motion. If the plant is shy of ammonia, the liquid pipe will be warm to the touch and the mixture of gas and liquid rushing through will rattle the liquid pipe and the vibrations can be plainly felt. Once an operator gets the "feel" of the thing, he never forgets it. And instantly, in any plant, he can tell if it has ammonia charge enough by looking at the gages and feeling of the liquid ammonia pipe.

I have had some odoriferous experiences with ammonia gage glasses, and now I never use them. When I first got the feel of the liquid going to the expansion valves, I abandoned the use of gage glasses on the high-pressure side, but still used them on process coolers on the low side.

Preventing Breakage of Gage Glasses

Once I had a brine cooler of the type shown in the sketch. It was much like a return-tubular boiler with 2-in. tubes set in a head; the brine was circulated through the tubes by a pump. The expansion valve is shown at *A*, the suction to the compressor at *B* and a gage glass about as shown. With the exception of the ¾-in. pipe connecting the top and bottom gage pipes,



CONNECTIONS TO SHELL BRINE COOLER

the pipes from the cooler to outside the brine tank were two feet long and "springy," so that there was trouble with glasses breaking and leaking. In elevator pressure-tank practice the same kind of trouble is experienced, and some bright fellow had the idea of connecting the top and bottom gage pipes together with pipe and fittings to stiffen the gage cocks and glass. I had operated elevators in which the pressure-tank glass for indicating the amount of cushion air was arranged as shown. The first chance we got we stiffened the gage connections as illustrated. I was agreeably surprised to find the frost line on the pipe *P* kept at the same level as the liquid in the glass *G*, and soon learned to depend on this frost line as the means of telling when to open or close the expansion valve *A*. We left the gage glass closed off.

Connected as shown, a piece of bare pipe is a reliable indicator of the liquid level in coolers, and there is no danger of bursting compressors with liquid as the contrast between the bare pipe and frost can be seen from a considerable distance, while it needs close scrutiny on the part of the operator to see the liquid in a cloudy, damp glass.

When the first feel of gas in the liquid pipe shows, connect a drum of anhydrous and let it run in until all the pipes are sealed, and then shut it off, as ammonia lying idle in the system is using the firm's money ahead of time.

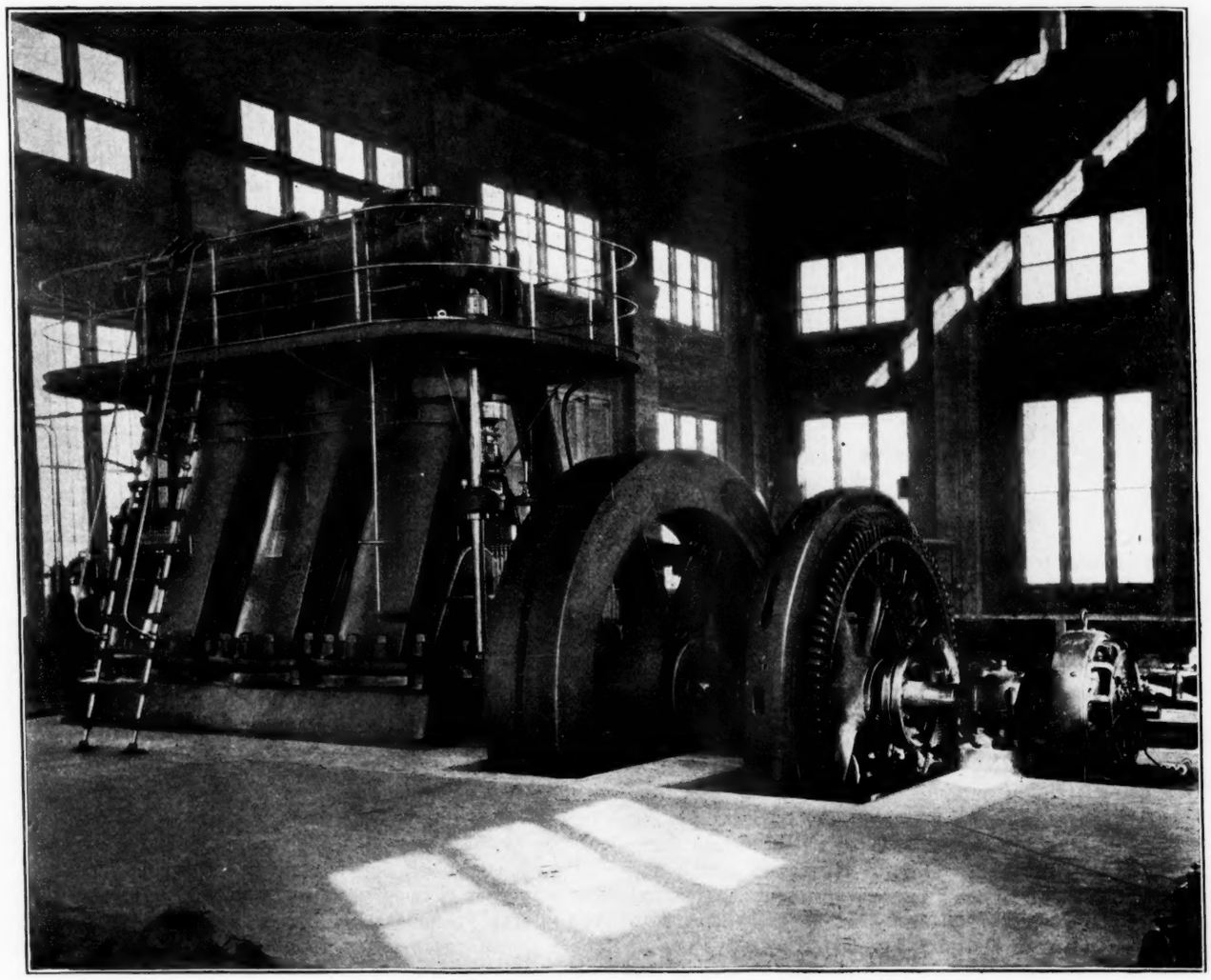
A Diesel-Engined Municipal Light Plant

In Marked Contrast to the History of Small Steam-driven Municipal Power Plants, the Miami, Oklahoma, Diesel Station Shows Decided Earnings

THE history of the average municipal light and water system is not an attractive one. Even the advocates of municipal ownership of public utilities base their arguments on grounds other than low cost. The town of Miami, Oklahoma, however, has a light and water system that not only is able to meet all expenses, but also shows a substantial net earning each month. Miami is one of the newer towns in the northeastern part of Oklahoma which came into existence as a result of the discovery of lead and zinc deposits in that section of the state.

The plant, originally installed to furnish water and light to the city, consisted of a Corliss engine and horizontal-tubular boilers. The water was handled by a steam-driven pump. Even though the town is in close proximity to the Kansas coal fields as well as to Oklahoma oil and gas fields, the plant was always a burden to the community; each year a tax was levied to meet the current expenses of the system. This deplorable condition forced the city to issue additional bonds and install a modern plant.

In the spring of 1919 a concrete building was erected and a Fulton-Tosi 385-hp. Diesel engine direct-connected to a 250-kva. Westinghouse alternator was installed. The steam-driven water-works pump was replaced by an airlift system. The air is furnished by a motor-driven Sullivan angle compound compressor, while a motor-driven two-stage centrifugal pump forces the water into the city mains. The power required by these motors is supplied by the Diesel set with a recording watt-hour meter, and a bookkeeping charge is made against the water department for this power at $0.05 per kilowatt-hour.



MIAMI, OKLAHOMA, DIESEL-DRIVEN ELECTRIC-LIGHT PLANT

The Fulton-Tosi engine has been in operation for more than a year, giving 24-hour service. The unit is shut down on Sunday mornings, when any necessary adjustments are made. The service is extremely severe, since the shutdown period is insufficient to allow any

considerable amount of work to be done. Notwithstanding this the operation has been entirely successful, and it is doubtful if any one-engine plant can show a better record of continuity of service.

The fuel used is a 28- to 32-deg. fuel oil and is of a character that causes but little valve trouble. The exhaust valves are ground every four months, while the practice is to pull the pistons every nine months. During the year of operation no serious trouble has occurred beyond the burning of one piston pin. The lubricating device for the piston pin is fastened on an angle iron, which in turn is secured to the A-frames. This angle became displaced, and since no oil reached the pin, the latter was ruined.

TABLE I. POWER PLANT COSTS PER KILOWATT-HOUR, MAY 1–30, 1920

Kilowatt-hours output	178,000
Fuel oil, gal.	14,003
Fuel cost per kilowatt hour ($2.55 per bbl.)	$0.00483
Labor cost per kilowatt-hour	.00518
Lubricating oil, etc.	.00580
Insurance and taxes, 4 per cent	.00170
Depreciation, 6 per cent	.00250
Interest, 6 per cent	.00250
Total cost per kilowatt-hour	$0.02251

The load caused by the engine ranges from one-third load for fifteen hours to full load for about three hours in the evening. The heavy load comes on rather suddenly, but the engine shows no bad effect from it. There is no tendency toward overheating of any of the parts. The cooling water is kept at a low temperature, never exceeding 110 deg. As a result of the successful record of the engine the city has recently purchased a second Fulton Diesel of 600 horsepower.

In the accompanying tables is shown the financial record of the plant for the month of May, 1920. Considering the light plant alone, the cost of producing power is 2.25c. per kilowatt-hour. This includes fixed as well as operating charges. This compares quite favorably with larger plants in view of the low load factor.

TABLE II. INCOME AND EXPENSE OF LIGHT SYSTEM

Total investment, water and light	$330,080.76
Depreciation, 5 per cent	1,375.00
Interest on bonds, 5 per cent	1,375.00
Labor	923.02
Maintenance	30.60
Lubricating oil, supplies, etc.	1,040.42
Total charges	$4,744.04
Income:	
Commercial lighting	3,584.47
Power	484.81
Water collections	2,105.46
130 Street lights at $2.50	525.00
89 fire hydrants at $4	356.00
City Hall lights	9.60
Total income	$7,065.34
Net earnings	2,321 30

Operation and Adjustment of Turbine Machinery IX—Assembling and Draining Packing

By EUSTIS H. THOMPSON
Consulting Engineer, Baltimore, Maryland

CARBON packing and the packing casing should be carefully cleaned. A sharp putty knife is the best tool for this purpose. Try the packing in the groove of the casing to make sure that it works freely. Also, as a final test before assembling, the entire ring should be assembled around the shaft. It can then be seen immediately if the ring is smaller than the shaft, and an idea can be gained of how much it exceeds the shaft diameter.

In using strings for tying packing when assembling, be careful to remove these, as they are liable to slip out of place and become jammed. With garter-spring packing it is permissible to tie up a ring with string and assemble the garter spring directly over the string to hold it in place. However, it is never necessary to leave strings inside the packing casing.

Metallic labyrinth packing rings sometimes rub on the shaft when assembled and produce vibration. It is often possible to wear these rings large enough to clear the shaft by bringing the turbine up to speed a number of times. Each time the machine is brought up to the speed at which it vibrates, hold it there a few minutes before lowering. Each time the ring will be cut out a trifle more, and with only a slight clearance to be gained thus, it can be made to operate satisfactorily without the necessity of dismantling.

With some types of packing it is often noticed that leakage occurs after the shaft has been moved, as would be required in taking out a bearing. This leakage will gradually disappear, often requiring several days' time, and is caused by the rings not easily coming back to their proper position. They can be made to take their right position by tapping the carbon casing with a hammer, which would be better than having them leak for a day or two.

The drains in carbon packing should always be open while the machine is shut down. There is often slight leakage from the throttle valve or sealing steam line, which causes water to collect in the casing. When the machine is put in operation, it is necessary, of course, in condensing turbines, to turn on the sealing steam. This acts best when the atmospheric drains are closed. In this case the excess steam condenses and leaks out of the casing a few drops at a time. The water contained in the casing acts as a lubricant during operation. Sometimes it is good practice to open these drains into the engine room itself, so that the excess steam will come out of the drain and indicate that there is sufficient sealing steam present.

Packing rings generally need no lubrication. If the steam contains alkali or sticky sediment, it is advantageous to lubricate with water and powdered graphite at proper intervals in accordance with conditions.

On windy days it is sometimes noticed that carbon packing from high-pressure stages or those pressures above atmosphere leaks badly. This is often caused by the outlet for the packing drains being in such a position outside the building that the wind blows directly into it, causing back pressure.

In starting a condensing turbine, there is usually a quantity of water condensed in the pipe that supplies the sealing steam. It is therefore necessary to be careful in turning on this steam when starting the turbine. It should be turned on slowly until the water has drained

through the rings so that water hammer will be prevented and damage to the delicate packing rings thus avoided.

It is not always necessary that shaft packing should hold tight. When sealing against a vacuum, a slight leakage is often desirable to insure a sufficient amount of steam for sealing purposes. On account of the limited space an elaborate arrangement of packing rings cannot always be placed, and therefore these rings are made as few and as durable as possible.

The actual limits of performance of shaft packing are often determined by the piping of the drains. These should not be led into a sewer where back pressure exists, as this, in nearly every case, will cause leakage at the machine.

Comparison of Power Flow

By Leonard A. Doggett*

In a steam-power plant raw material in the form of fuel is manufactured into either mechanical or electrical power. It may occur to the power-plant engineer to follow his product through the manufacturing process, which may easily be visualized as in Fig. 1. Energy is stored in chemical form in the coal pile. When the coal is burned under the boiler, power flows from the boiler through the pipe to some sort of prime mover, in this case a steam engine, which converts this thermal power into a mechanical form at the shaft. Thence it is transmitted as mechanical torque at some definite speed to the receiver of power, which may be mechanical load in the shape of lineshafting or what not, or it may be an electrical generator as in the figure. In this latter case the mechanical power is converted into electrical power and as such is transmitted over wires to the various receivers of electrical power, which is represented by a motor.

In order to picture in a more definite way the "size" so to speak, of the different parts in various power-generating equipment, Fig. 2 and the table have been prepared. The interpretation these may be given is somewhat as follows:

For example, in the first case about 400 kw. of power flows along the 3-in. steam pipe, requiring the use of 8 lb. of material per running foot. The next step consists of the extraction by the prime mover of some 55 kw. of power, which is passed along a shaft to a set of reduction gears. Approximately 53 kw. reappears at the 1,200-r.p.m. generator shaft, which is $3\frac{3}{4}$ in. in diameter and weighs 38 lb. per running foot. Following the power still farther through the generator, it will be found that 50 kw. is available and that this power is in such a form that it can now be supplied by a 0.7-in. diameter wire, weighing a little less than 2 lb. per running foot. Electrical power differs from the other forms of power in that it needs a return circuit, so that half of the area of the 0.7 in. wire is to be allotted to the outgoing current and the other half to the return current. A similar analysis may be applied to the other cases, but in all the conclusion is the same—electricity is the most compact form in which power can be transmitted. Fig. 1 simply shows to scale the size of shafts, steam pipes and electric wires, going and return, for four small steam-electric units. These figures neglect all considerations of shaft bearings, pipe lagging and supports, and

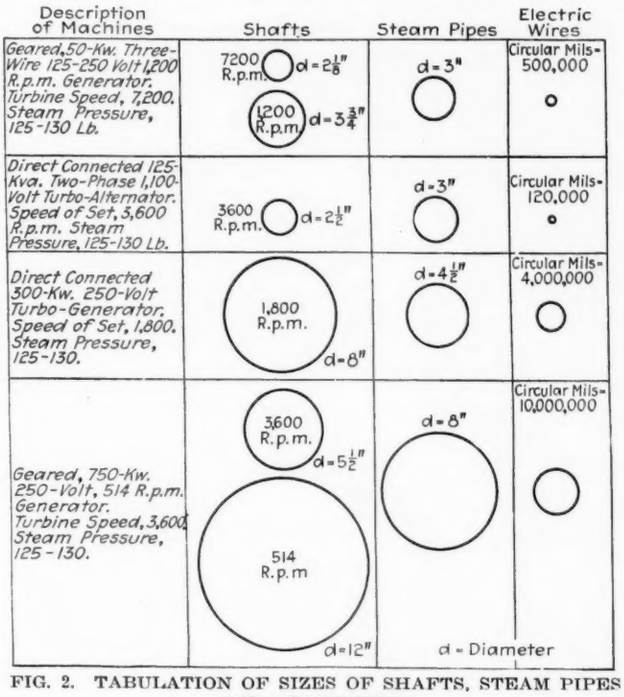

Description of Machines
Shafts
Steam Pipes
Electric Wires
Geared, 50-Kw. Three-Wire 125-250 Volt 1,200 R.p.m. Generator. Turbine Speed, 7,200. Steam Pressure, 125-130 Lb.
7200 R.p.m.
d = 2 1/8"
1200 R.p.m.
d = 3 3/4"
d = 3"
Circular Mils-500,000
Direct Connected 125-Kva. Two-Phase 1,100-Volt Turbo-Alternator. Speed of Set, 3,600 R.p.m. Steam Pressure, 125-130 Lb.
3600 R.p.m.
d = 2 1/2"
d = 3"
Circular Mils-120,000
Direct Connected 300-Kw. 250-Volt Turbo-Generator. Speed of Set, 1,800. Steam Pressure, 125-130.
1,800 R.p.m.
d = 8"
d = 4 1/2"
Circular Mils-4,000,000
Geared, 750-Kw. 250-Volt, 514 R.p.m. Generator. Turbine Speed, 3,600. Steam Pressure, 125-130.
3,600 R.p.m.
d = 5 1/2"
514 R.p.m
d = 12"
d = 8"
Circular Mils-10,000,000
d = Diameter

FIG. 2. TABULATION OF SIZES OF SHAFTS, STEAM PIPES AND CONDUCTORS

electric-wire insulation and spacing. The great number of variables entering into the design of all three of these tabulated figures, such as speed, steam pressures, superheat, voltage, length of line, etc., would inevitably lead to a wide variation in the sizes of the circles. However, one generalization from Fig. 2 is true for all ordinary cases—the cross-section representing the electric wires is the smallest of the three cases.

POUNDS PER LINEAR FOOT OF TRANSMITTING MATERIAL

Size of Set		Shafts	Steam Pipe	Electric Wires
50 kw.—	Turbine	12	8	1.8
	Generator	38	...	...
125-kva.		17	8	0.5
300-kw.		171	12	12
750-kw.—	Turbine	81	30	31
	Generator	385	...	...

The electric wire sizes represent the area of cross-section of the wires, going and return, and have been determined by the rules laid down in "Current-Carrying Capacity of Electric Cables, U. S. Navy," by Lieutenant Commander A. M. Charlton, U. S. N., Vol. XXXI, No. 4, November, 1919, A. S. N. E. Proceedings.

*Professor of Electrical Engineering, United States Naval Academy, Annapolis, Md.

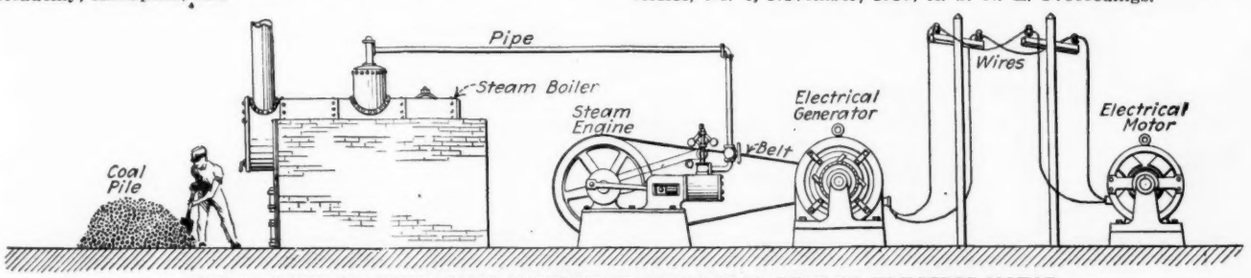
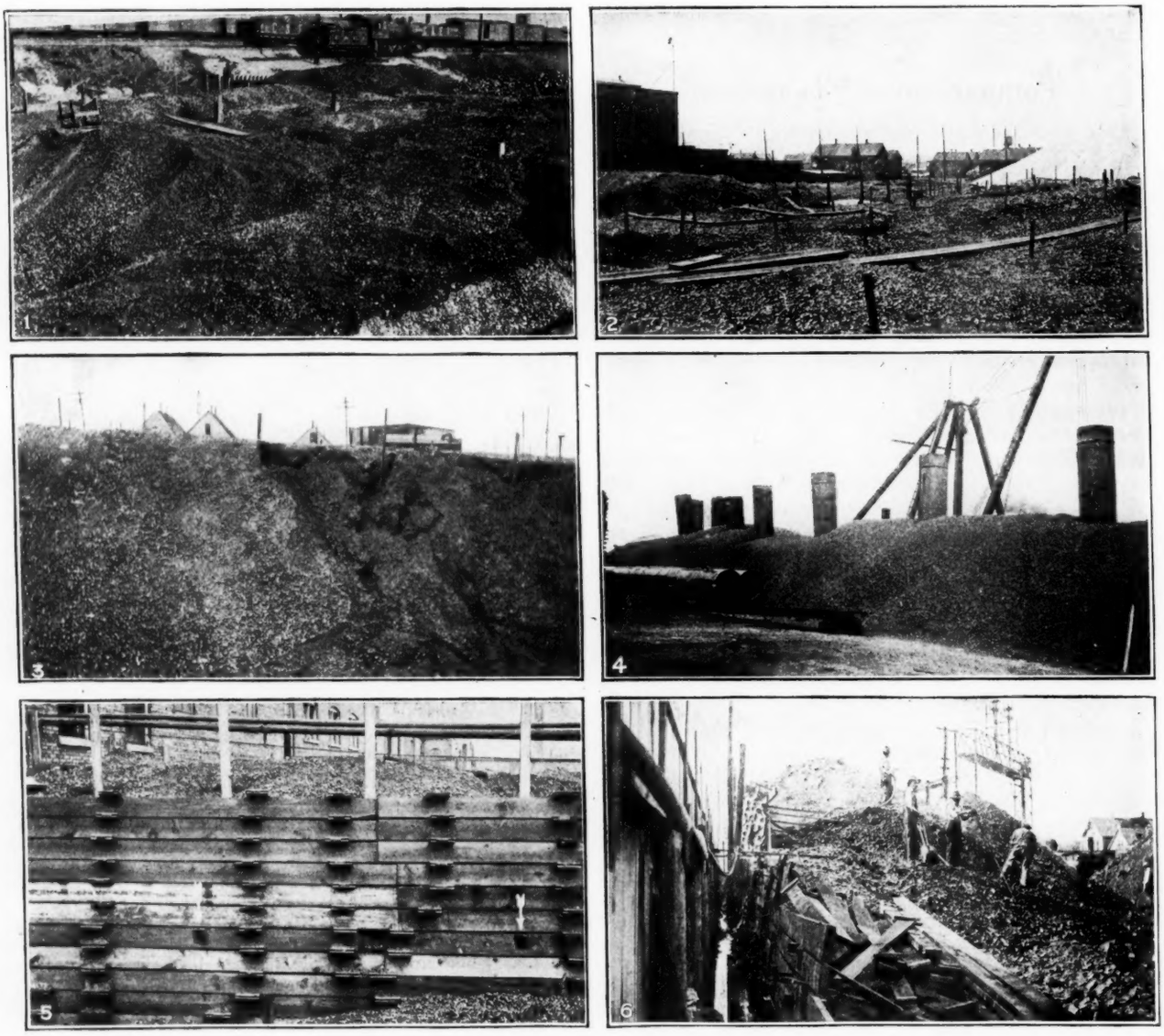


FIG. 1. POWER-GENERATING EQUIPMENT FROM COAL PILE TO ELECTRIC MOTOR

Ventilation of Coal in Storage

By W. D. LANGTRY
President, Commercial Testing and Engineering Company, Chicago, Illinois

THERE seems to be a great difference of opinion on the subject of the ventilation of coal in storage. The accompanying views give some idea of the methods employed by chief engineers and managers of industrial and municipal plants. During the war the owners of storage piles tried to protect them as much as possible. Invariably, "ventilation" was the one method thought best, until the pile started "to go up in smoke." It might be interesting to notice that the coal piles in Figs. 1, 2, 3 and 5, all of which show attempts at ventilation, caught on fire. Fig. 4 shows a pile of sized coal, 1¼ x ¾ in., ventilated by large pipes. There is little doubt that this coal would have stored just as successfully without the pipes as it did with them inserted. When this pile was inspected, the suggestion was made to leave the pipes as originally placed to see if a fire would start, but there was no evidence of spontaneous combustion three or four months later. No attempt was made at ventilation of the pile shown in Fig. 6, but the wooden anchors were the means of admitting the air into the pile, which later caught on fire.



FIGS. 1 TO 6. SOME ATTEMPTS AT VENTILATION

Fig. 1—Vents made out of wood. Fig. 2—Numerous gas pipes for ventilating purposes. Fig. 3- Vapor coming out of ventilator pipe. Fig. 4—Large flues inserted for ventilating purposes. Fig. 5—Horizontal ventilation. Arrows points to ends of wood vents. Fig. 6—Retail yard in which wooden anchors admitted air to pile.

There is no doubt that ventilation is a good thing and will make the storage of coal safe, if sufficient air is supplied to carry away the gases and keep the coal below the ignition temperature. How to determine the degree of ventilation is the problem. Where air is admitted into the interior of a pile of coal oxygen comes

in contact with the coal and oxidizes it. It is necessary that there be ventilation sufficient to take away the gas so generated, but in many cases there has been just enough oxygen admitted to start trouble.

A rather interesting incident happened at a plant in Michigan. Coal had been placed under cover in a bin about 25 ft. wide, 50 ft. long and 20 ft. deep. As the coal built up two ventilating pipes were inserted, one extending about two feet and the other about four feet above the top of the pile. Smoke from a cigarette was blown across the mouth of the shorter pipe, and strange

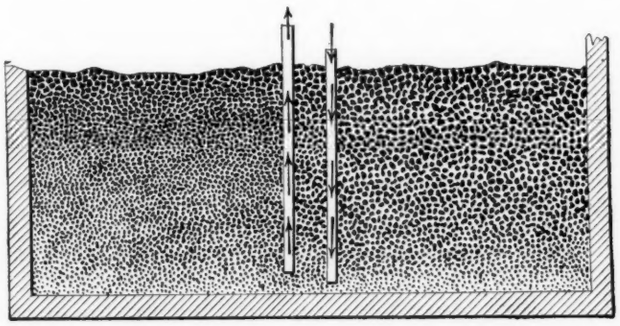


FIG. 7. CHIMNEY EFFECT FROM VENTILATORS

as it may seem, it was immediately drawn downward. Smoke blown across the top of the longer pipe indicated an upward current. There was a chimney effect pure and simple. This storage pile had to be moved to save it from complete destruction.

In Canada the railroads have made a practice of ventilating their coal-storage piles. By observing rigid precautions they claim that spontaneous combustion can be prevented. It should be kept in mind, however, that the temperatures in Canada range somewhat lower than in this country. Climatic conditions may have an important bearing on the success of any method of ventilation, and what seems to be satisfactory in a cooler climate might not be so in a locality where the temperature is higher and the humidity greater.

This question always presents itself, Would not the pile that has been ventilated successfully have gone through without a fire if no ventilation had been attempted? It is almost impossible to place two piles of coal in exactly the same way and have the same percentage of fine and lump in each, and then try to ventilate one and not the other for comparison. There are too many variables to contend with, so conclusions or opinions can be reached only from experience. In this regard the following quotation from Bulletin No. 116 from the University of Illinois, now in the course of printing, may be of interest:

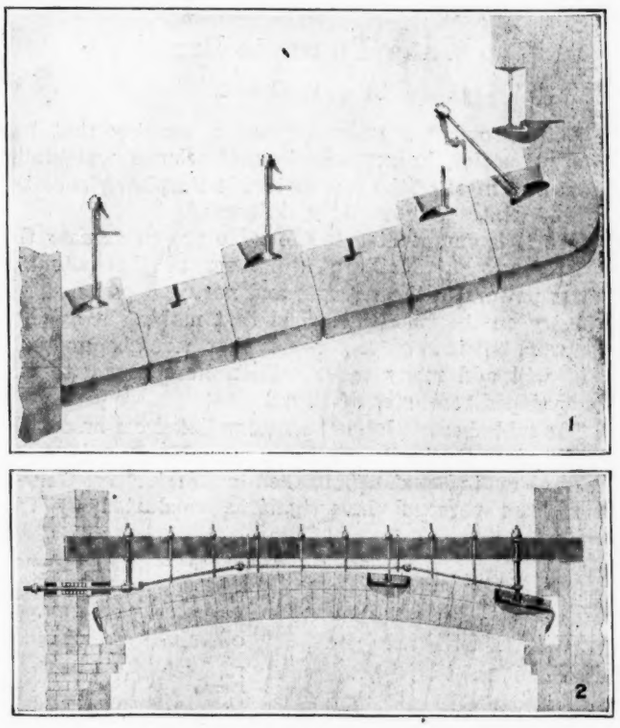
> In 16 of 303 storage piles reported on, an attempt had been made to ventilate by means of iron or wooden pipes. In 11 of these 16 piles fire occurred. These results do not suggest that ventilation as carried on is an efficient means of preventing spontaneous combustion, and they agree well with the data secured in the study of the fires in Chicago.

It would seem from the evidence presented to date that ventilation should be looked upon as more of a danger than a corrective for the successful storing of coal, the reason being that it is really never known when sufficient ventilation actually takes place. It may be the means of supplying just the ingredient that is wanted to start combustion.

Stevens Suspended Sprung Arch

A suspended sprung arch designed to eliminate the spawling of the flat arch and the intense lateral compression of the sprung arch, has been recently developed by E. P. Stevens, now associated with the James A. Brady Foundry Co. of Chicago. The features of the new arch are shown in the accompanying illustrations. It will be noticed that the arch is formed of a series of rows of brick interlocking one with another, each row consisting of a series of standard shaped brick tapering sufficiently to give a slight curvature to the arch and to prevent any individual brick or a piece that has become separated from falling out of the arch. The bricks in every other row have extended heads perforated and slotted to accommodate cast-iron hanger plates supporting four adjacent bricks. The hanger plate is suspended from a transverse beam by a bolt having its head between two ribs of the plate and extending through a special hooked plate and nut at the top, engaging with the steel supporting beam.

In the alternate rows the bricks are shouldered to interlock with the others and can be removed by inserting a key into a slot provided for lifting them out of place. Thus the arch is suspended in groups of four



TWO VIEWS OF THE STEVENS ARCH

brick, and the entire weight is carried on the supporting beams, so that it is independent of any support by the side walls or brickwork. In the side walls provision is made for free movement of the arch to eliminate the side thrust or compression strain in the arch itself that might otherwise be imposed, due to expansion and the curvature of the arch.

To supply the slight side pressure necessary to keep the bricks together, the two outside supports are connected by link rods and a spring, which is compressed as the arch expands. When the arch cools and contracts, the spring exerts enough pressure to keep the brick in

close contact. The spring is carried in the side wall, where it is away from the heat and can easily be inspected or replaced. The compression of the spring may be adjusted from outside the setting.

Owing to the method of supporting separately the brick in groups of four by independent hangers which are adjustable in all directions and carry only the weight of the four bricks, it is an easy matter to repair the arch, as each group is independent of the other and one may be removed without disturbing the balance of the arch. The alternate rows can be removed without difficulty even though the furnace be in use at the time. As the brick are slightly welge-shaped, they may be lifted out readily through the top of the arch by means of the key provided for this purpose. As the supports are exposed to the cooling air above the arch and are not buried in the brickwork itself, there is little likelihood of deterioration, so that the arch cannot fall except by the actual burning off or wearing away of the brick.

It has been stated that arches built on this principle have been in constant service in boiler practice for 3½ years. The same arch can be built of silica brick at any slope to the horizontal, so that it is particularly suitable for open-hearth furnaces and other forms of metallurgical service in addition to use in the boiler plant.

Water Power in Brazil

By J. B. Crane

With growing scarcity of coal a country that has twenty million horsepower in undeveloped waterfalls, as well as most of the raw materials that have made the United States famous, is of interest.

The falls enumerated in the table are on or near the Atlantic coast. Nothing is known of the potential water powers in the western and northern parts of the country on the vast watershed that makes the mighty Amazon, but it is quite probable that here also are falls that will add many more million horsepower to the undeveloped resources of Brazil.

The table herewith has been compiled from an article by Dr. Frontin in "A Hulha Branca No Brazil" (The White Fuel in Brazil), published in *Brazil Ferro-Carril*, and from personal investigations conducted by the writer.

Name of Fall	Height in Feet	Name of River	Estimated Horsepower
Paulo Affonso	260	San Francisco	1,000,000
Bannerais	...	Paraguassu	30,000
...	...	Parauna	60,000
...	...	Carandahy	30,000
San Maurcino	320	Nova	18,000
Sapucaia	90	Parahyba	100,000
Pombas	75	Parahyba	80,000
Piabanha	...	Piabanha	78,000
Lage	...	Pirahy	60,000
Dourada	190	Paranahyba	400,000
Marinbonda	...	Rio Grande	800,000
Avanhandava	45	Tiete	60,000
Itapura	37	Tiete	50,000
Uruba-Punga	33	Parana	450,000
Onca	...	Parana	220,000
Sete Quedas	420	Parana	20,000,000
Iguassu	210	Iguassu	3,000,000

The tabulation gives a total of over 26,000,000 hp., of which Lage (60,000 hp.) and 3,000 hp. at Maurcino have been developed.

The table does not include the many small powers, 500 to 15,000 hp., already developed and supplying power and light to neighboring towns, for there is scarcely a town of 1,000 inhabitants within 600 miles of the coast that does not have a modern electric lighting system operated from hydro-electric power with a "white way" that beats that of any city of a similar size in the United States.

There have been several references to the falls of the Iguassu, and even in Brazil the information was as vague and general as here. One geography there ascribes 14,000,000 hp. to this fall, and, until the writer reached Paraguay, he was unable to obtain any reliable information on the possibilities of this fall.

The Parana and Its Tributaries

The River Parana rises in the state of Minas Geraes, Brazil, flows in a southerly direction and is reinforced by innumerable other streams. Finally joined by the Uruguay River, it forms the dividing line between Argentina and Uruguay and flows into the Atlantic Ocean as the Rio La Plata. It drains the fourth largest territory in the world and is about as large as the Mississippi.

River	Approximate Square Miles of Drainage Area
Amazon	2,320,000
Nile	1,620,000
Missouri-Mississippi	1,238,642
Parana-La Plata	1,200,000

The Falls of Guayra, or Sete Quedas (seven falls), are located on the Parana River about one hundred miles north of Iguassu. These are a series of falls giving a drop of 420 ft. in a distance of six miles. Readings of flow were made by the Argentine government in 1914 and show flows of from 180,000 to 400,000 cu.ft. per sec. during three months of that year. On this basis there would be capable of development but 7,000,000 hp. at minimum flow instead of the 20,000,000 hp. shown in the table.

The Iguassu River flows into the Parana about one hundred miles south of Guayra and forms the boundary line between Brazil and Argentina at this point. Paraguay is on the west side of the River Parana. The falls are four miles from the junction point, and in the Parana River just below the junction is a deep gorge. During periods of high water this gorge chokes back the water so that the fall is only 70 ft. instead of 210 ft. This means 700,000 hp. instead of 3,000,000 hp., but it is still quite a respectable power and fully large enough to supply the needs of a city like Buenos Aires for several years to come.

Brazil's Industrial Development

Brazil has made a large industrial development since the war started, especially along textile lines, and is now importing cotton instead of exporting it. Some of the large plants near Rio de Janeiro are:

Company	Output	Employees
Fiat Lux Match Co	Matches	400
Brago, Costa & Co	Hats	200
Bangu Textile Mills	Cotton Goods	3,000
Pola Shoe Co	Shoes	240
Fabrica de Roupas, Cometas	Collars, cuffs and shirts	400
Glass Factory	Tumblers, lamp shades, etc.	200

Most of the factories are one story with a tile roof, as this gives a temperature inside about ten degrees cooler than outside. One factory tried asbestos shingles, but the inside temperature was so high it was necessary to substitute tile. The operatives are intelligent and easily taught, but have not yet begun to develop their powers of initiative and invention. It will be many years before the industries of Brazil will require much of the available water power, but anyone who is looking for large quantities of hydraulic power where there is an abundant supply of labor, easily taught, will find it in Brazil.

Steam-Engine Operation and Maintenance
Piston-Rod Packing

By H. HAMKENS
Consulting Engineer, Newton, New Jersey

MUCH time is spent and money wasted in keeping piston-rod and valve-stem packings tight. Of course nothing else can be expected if engineers will persist in using soft packings. There are various kinds of fibrous packings manufactured with claims of superior qualities. They may have a rubber core or a rubber back to give them elasticity; metallic wires may be inserted spun with asbestos, flax or some other fibrous material. Canvas, cotton, wool, soft metal and any other substance with a fiber are spun, woven or braided into all shapes and forms. Some are round, others square, flat, triangular, wedge-shaped, conical or any other form that strikes the manufacturer as particularly useful and for which a special claim of long

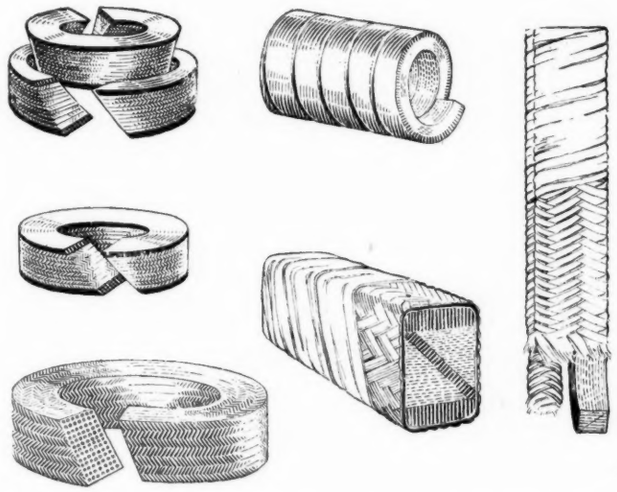


FIG. 1. SOME FORMS OF SOFT PACKING COMMONLY USED IN STEAM ENGINES

wear and excellent service can be advanced. A few of these packings are shown in Fig. 1.

These soft packings stand up satisfactorily under some conditions. In present-day engine practice metallic packings are extensively used, for with reasonable care they will give excellent service for years without bother and loss of steam and will keep the rods in good condition. As the name implies, these packings are made of metal—soft metal in many cases, but also of cast iron. They are made to suit any condition, even to take the place of soft packing, as shown in Fig. 2. In the former case the packing is made to fit into the bore of the old stuffing box and held in place by the gland, while in the latter (right, Fig. 2) a complete new packing box takes the place of the old gland. The packing rings are held against the rods by means of flat or spiral springs. Except for small rods and valve stems the cases should be split to facilitate their removal and to give access to the rings. It is of importance that no steam gets back of the rings, otherwise they will wear rapidly and are likely to score the rod. The most careful design and workmanship are essential. The rings must be self-adjusting to accommodate themselves to slight variations in the diameter of the rod and to take up wear.

In Fig. 3 two kinds of sectional rings are shown. The one to the right is cut in such a way that the faces of contact of the segments form an equilateral

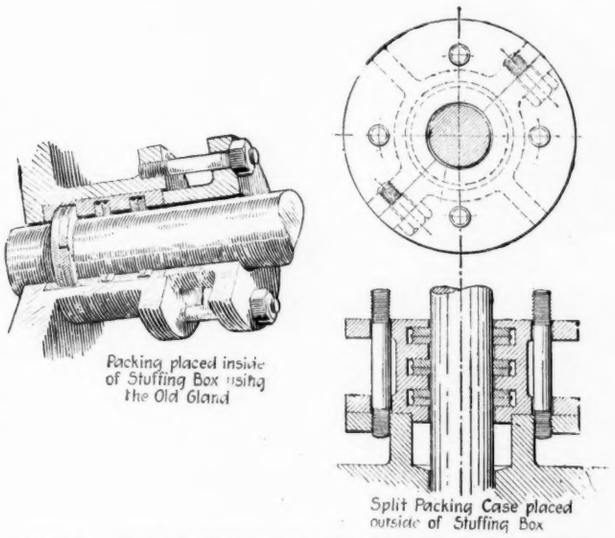


FIG. 2. APPLICATIONS OF METALLIC PACKING RINGS

triangle, the center of which coincides with the center of the rod; within certain limits, therefore, any slight inward or outward motion of the sections will not disturb this relation. Since the rings are cut in the form of a triangle, it is evident that there is a limit to the size of the rods for which this packing can be

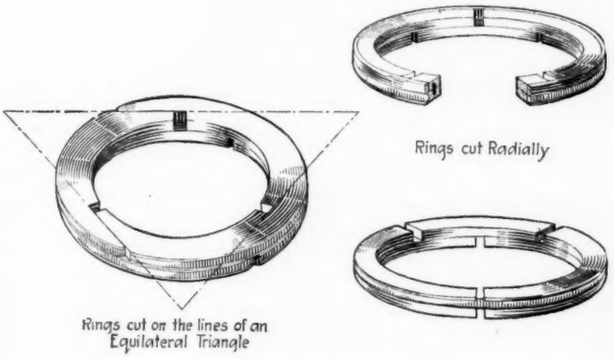


FIG. 3. TWO KINDS OF SECTIONAL RINGS

used. The other rings shown are split radially and the number of sections can be arranged to suit the size of the rod. For small and medium diameters three sections are mostly used, while for large rods the number can be increased to four, five or six, whichever is the most convenient.

A Question of Service Cost

By Julian C. Smallwood,*

This is the tale of a three-cornered fight between oil, gas and electric current.

A certain small but thriving manufacturing company in Baltimore has derived its power during the last ten years from an old-fashioned low-compression 50-hp. oil engine built by a prominent company. This engine has a remarkable record. Since installation its cylinder head has never been removed, its valves have never been reground, and it has required no repairs save for the renewing of a single bearing. In spite of the fact that its fuel has been low-grade kerosene (with water injection), it has never given trouble from carbon, it has started easily and plugged away faithfully nine hours a day throughout the working week and, were it not for the rising price of oil, would probably continue to do so up to the bitter end, like the Deacon's one-horse shay.

Up to the present all proposals on the part of the local electric company to displace this source of power have been met by the assertion that "the oil engine gives such excellent service as it stands." But, lately, with oil at fifteen cents and threatening to reach eighteen, the owner has given more serious attention to these proposals. The writer, as a result, worked out the costs of power to the owner under old conditions and compared them with costs, first, if the engine were converted to illuminating gas, and second, if electric current were bought.

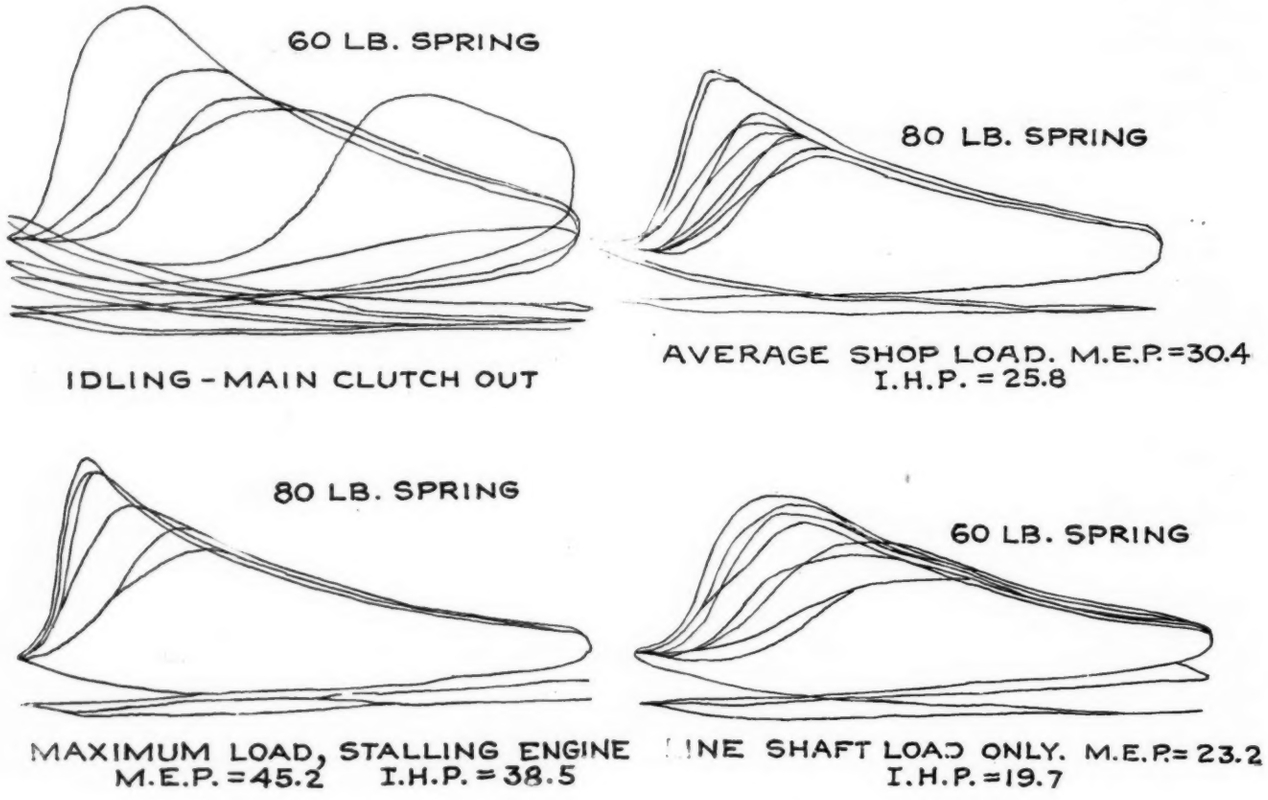
*Associate professor of mechanical engineering, Johns Hopkins University.

The first step was to investigate general factory conditions attending the use of oil power. It was found that the engine was operated by one of the mechanics, who was "broken in" to this work by the foreman, who was familiar with the engine and knew its tricks. In the morning the engine was started by compressed air, but it required three men to turn its flywheel to starting position, and these men generally stayed in the engine room for ten minutes or more until the engine was well under way. The same procedure took place when starting after the lunch hour.

The shops (on three different floors) are plentifully equipped with light machine tools and a few heavy ones, conspicuously a planer. Light operations are performed for the most part, but occasionally some heavy machines are thrown on. When this happens, the line-shaft slows down, whereupon the mechanic in charge of the engine drops his work, rushes to the engine room and nurses the oil and injection valves until normal speed is reached. Occasionally, when the planer goes on, all machine operations of the shop slow down because of the failure of the oil engine to meet the demand. This condition had become so usual that it was hardly noticed except by the engine operator, and in consequence the owners felt that their oil engine gave excellent service.

It is probably not too much to say that on this item alone the money loss during the last six years has run into the thousands.

As a next step the engine was indicated, the resulting diagrams being shown herewith. As the governor action was very irregular, composite diagrams were taken. The diagrams disclose slow burning at all loads



INDICATOR DIAGRAMS SHOWING BEHAVIOR OF OIL ENGINE IN SMALL PLANT

and ridiculously low compression pressure (30 lb.), probably due to leaky valves. As the engine would not idle, measurable friction diagrams could not be obtained. The diagrams show about 10 per cent of the net indicated horsepower to be used for pumping. Assuming 6 per cent of the maximum rated capacity for mechanical friction gives three horsepower to be subtracted from the net indicated horsepower to reach an estimate of the delivered horsepower. It was found that on this basis the maximum horsepower that could be held without material slowing down was only 36 instead of 50. This, of course, was due to the low compression and the late ignition. An average value of the delivered horsepower when no heavy tools were on was 23. The

COSTS FOR BLANK MFG. CO.—MONTHLY BASIS

Oil		
Fuel, 1,070 gal. a month at 18c		$192.60
Lubricant ($76.23 for six months)		12.35
Attendance (say one hour a day), at 80c. for 24 days		19.20
Water, at ½ cu.ft. per min. and 65c. a thousand		4.23
Allow $300 selling value of engine, 6 per cent interest, 2 per cent taxes and insurance, and 20 per cent depreciation (depreciation on repairs), making 2½ per cent per month		7.00
		$235.38
Gas		
Fuel, 28 cu.ft. per hp.-hr. for 6,510 hp.-hr. hours at 65c. per thousand		$118.40
Lubricant		6.00
Attendance, ½ hr. a day at 80c. for 24 days		9.60
Water, at 1 cu.ft. per hp.-hr.		2.11
Same overhead expense as for oil, say		7.00
Extra investment: Fittings for engine $150.00; Pipe line 300.00		
$450.00 at 1 per cent per mo.		4.50
		$147.61
Electric Current		
Average load with group drive as recommened, 15 hp. = 217 hr. use per month. Allowing 80 per cent efficiency of motors calls for 14 kw.		
Monthly consumption = 14 × 217 = 3,038 kw.-hr.		
Maximum demand = 27 hp. = 20.25 kw.		
400 kw.-hr. at 8c.	$32.00	
2,638 kw.-hr. at 3c.	79.14	
	$111.14	$111.14
Investment:		
Motors	$1,917.00	
Wiring and installation	700.00	
	$2,617.00	
Interest, depreciation, insurance and taxes on investment at 13½ per cent		29.44
Total monthly cost		$140.58

friction horsepower of the lineshafts and belts, found during the lunch hour, was 17. It thus appears that the actual working load under ordinary conditions is 6 hp. and that nearly three times this value is carried as transmission loss.

The fuel consumption averaged over a year gives 1,070 gal. per month of 217 working hours. This oil has a heat value of 133,000 B.t.u. per gallon. Assuming an average brake horsepower of 25 gives nearly 0.2 gal. per hp.-hr., or a thermal efficiency of only about 9 per cent.

Yet the oil engine gave excellent satisfaction! When analyzed, the satisfaction was due to the fact that it had occasioned no trouble.

The high fuel consumption is partly due to too low a jacket temperature for good vaporization of the oil. It seems that, because the operator was engaged in other work, a high jacket temperature might occasion unobserved overheating.

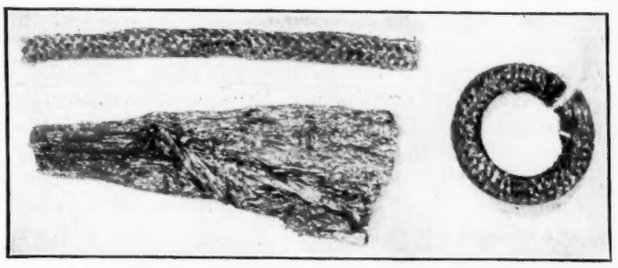
The writer was anxious to convert this engine to gas, raising its compression pressure to 100 lb. for 500-B.t.u. gas. But owing to the fact that the cost for current with group drive worked out less (due to the big friction loss), he was obliged to advise in favor of central-station current. There were other considerations also, principally that of slowing of production due to the engine, even at rated capacity, being unequal to the maximum demand, future requirements, etc.

The accompanying table shows the reckoning of costs.

This story, of course, has to do with only a small quantity of power, but it has a big lesson if you wish to take it. How many manufacturers of power, small and large, really know the costs of power? How many engine operators really know whether their engines are actually giving good service and not merely occasioning no trouble? And finally, would the central station in this case have won if this particular engine had been kept up to maximum efficiency, with full compression pressure and proper timing of ignition?

"Metalpac" Flexible Metallic Packing

A flexible all-metallic packing known as "Metalpac" is manufactured by the Goodsell Packing Co., Inc., Maywood, Ill. It is composed of continuous thin metallic sheets that are passed through a lubricant bath and crinkled so that the material is as pliable and compressible at the center as it is at the outer surface, and at



METALLIC SHEETS, COPPER BRAIDING AND FINISHED PACKING RING

the same time it is indestructible against high pressure. These metal sheets are covered with soft braids of copper wire, which eliminates the possibility of flaking.

This packing is made for steam, air and vapor, also hydraulic pressure and all liquids. It comes on reels, when desired, in a continuous length, thus avoiding waste, and is also made in coils and rings.

English Railroad Adopts Fuel Oil

Many of the Western railroads, after using fuel oil on their locomotives for many years, have returned to coal. The meager oil supply and the consequent high prices have made its further use uneconomical. It is somewhat surprising to learn that an English road, the London & North Western, has equipped one of the locomotives with oil burners. Extensive tests appear to prove that the operation is superior to that of a coal burner.

In view of the cost of fuel oil it is hardly probable that it will be used very extensively on English roads, but it will provide a means of continuing operation even though a general strike of the coal miners does occur.

There is an increasing demand that all fuel entering into interstate commerce should be inspected just as grains, cotton, and other agricultural products now are subject to Government inspection. There is evidence that coal operators are viewing with more favor the proposed extension of this work.

Stowe Forced-Draft Stoker

A NEW type of forced-draft stoker consisting of traveling chain-grate elements alternating with stationary tuyeres has been developed by the Laclede-Christy Clay Products Co., of St. Louis. The entire grate surface is inclined at an angle of twenty degrees to the horizontal to facilitate the conveying function of the chains. Both the moving and stationary parts of the grate are provided with air spaces of relatively small area through which air is forced by a uniform draft pressure not exceeding two inches of water. The tuyeres are made up of short interchangeable sections containing varying percentages of air space, so that the total passage of air, including that through the chains, through any particular section of the grate, may be varied to suit the fuel. With high-volatile fuels such as the bituminous coal of the Middle West or with the caking coals of the East, the air space is made greatest at the front of the stoker, while with coke breeze or other fuels containing little volatile, the tuyere sections containing the larger air spaces are placed farther back. By concentrating the reflected heat at the front of the stoker the coking qualities of Eastern coals are destroyed so that on the grate they burn as any other fuel, admitting air freely through the bed. Because of an even grate surface and no agitation of the fuel bed, highly volatile, high-ash bituminous coal is burned without clinkering. The stoker is thus designed to consume a wide variety of fuels at different rates of combustion up to sixty pounds of coal per square foot of active grate surface.

From the accompanying illustrations an idea may be obtained of the general arrangement and construction of the stoker. Fig. 2 shows the inclosed front of the stoker, and Fig. 1, a sectional elevation, indicates the relative positions of the grates, feed gate and hopper. The coal resting on the chains and dead plates just below the hopper forms an air seal between the windbox and the furnace. As the chains move forward, they carry the fresh coal under the feed gate, where it is leveled off and the depth of bed adjusted by means of the handwheel *A*, Fig. 2. The indicator *B* is to show the operator the thickness of the fuel bed. The initial uniformity is maintained as the fuel bed is not disturbed after it leaves the gate, but is supported and carried forward by the conveyor chains without undue agitation.

Fig. 3 shows the grate surface, consisting of the conveying-chain elements *A*, alternating with the stationary tuyeres *B*. The chains are $4\frac{1}{16}$ in. wide and the tuyeres about $2\frac{1}{8}$ in. The tops of the tuyeres are smooth and depressed slightly below the chains. From the feed gate to within a short distance of the bridge wall the grate surface slopes downward at an angle of twenty degrees to the horizontal. Near the bridge wall the grate surface rises to form a short section which is practically horizontal, to hold back the spent fuel, giving the remaining particles of combustible an opportunity to burn and also increasing somewhat the thickness of the fuel bed at the rear of the furnace.

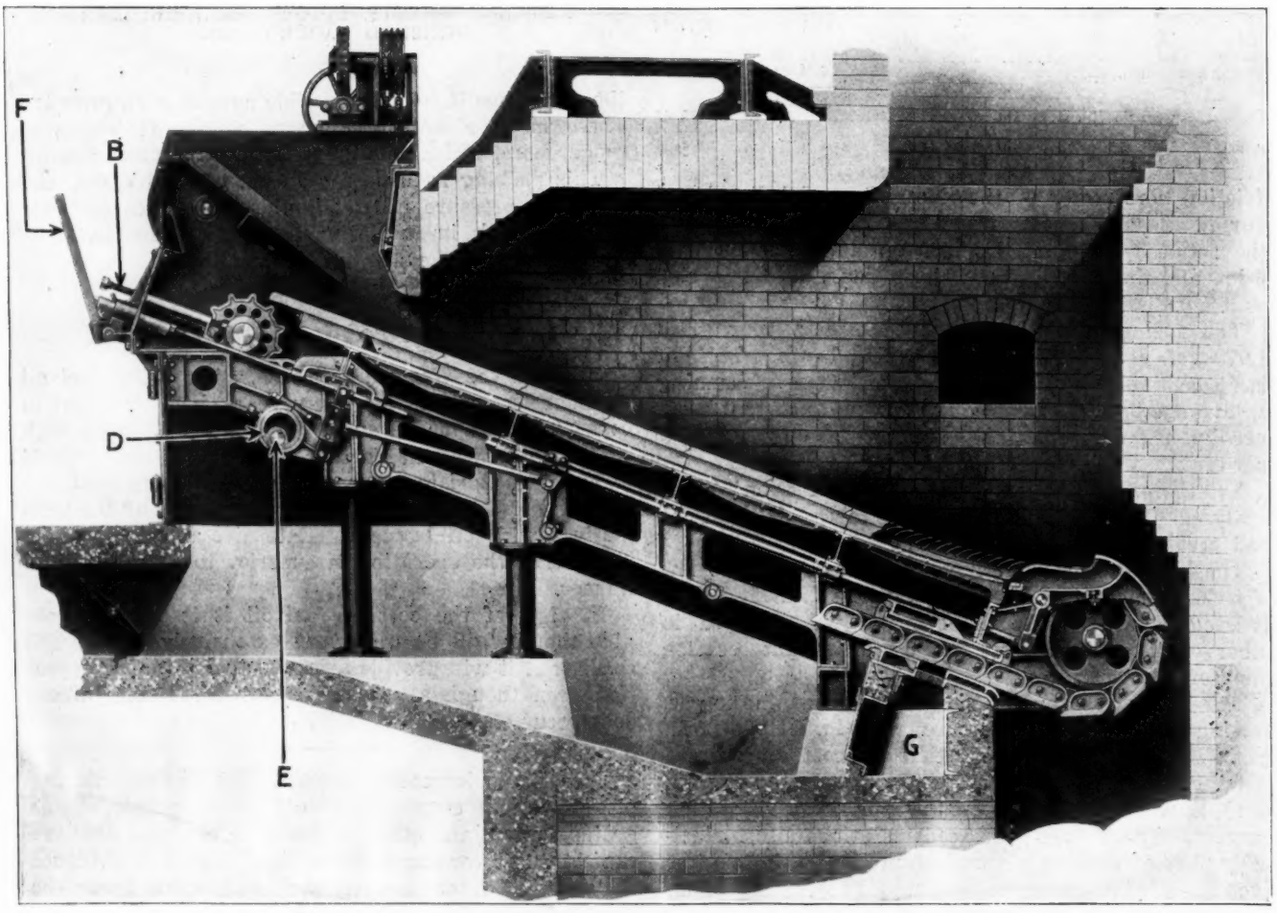


FIG. 1. SECTIONAL ELEVATION OF STOWE STOKER IN POSITION IN FURNACE

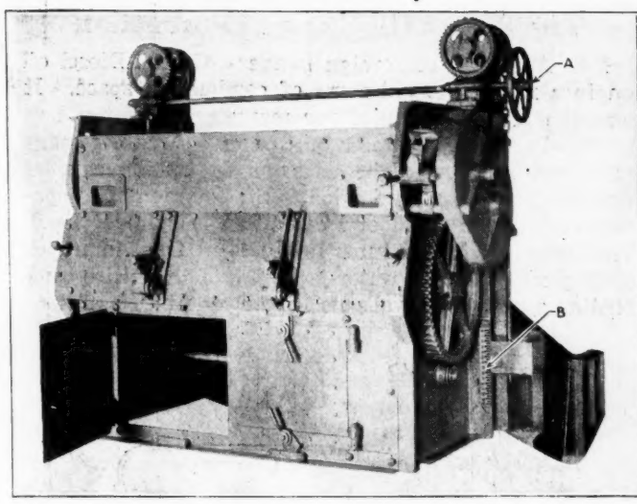


FIG. 2. INCLOSED FRONT OF STOWE FORCED-DRAFT STOKER

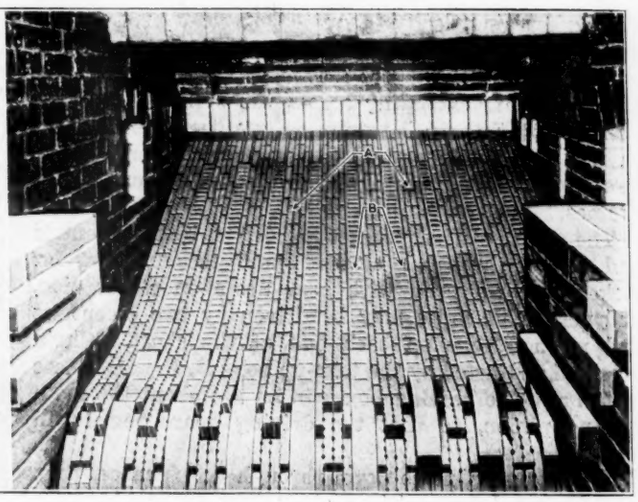


FIG. 3. SHOWING STATIONARY TUYERES AND TRAVELING ELEMENTS

Referring again to the sectional view, Fig. 1, it will be seen that the high arch, the large area of the face of the bridge wall and the sharp incline of the grate, all combine to subject the fuel bed to intense reflected heat, so that high fuel-bed temperatures must prevail; but as there are no restrictions to the gas passage, the heat is not "bottled up" in the furnace. These high fuel-bed temperatures tend toward high rates of burning and efficient operation.

Reference to Fig. 4 will show that the chains are made up of four rows of links, which are short, deep and narrow when compared with the conventional chain-grate link. The deep web and the air veins give proportionately greater cooling surface, and this feature, combined with protection afforded by the thick layer of refuse and combustible near the bridge wall, tends to increase the life of the links. The chains are fabricated with eccentric steel pins mounted within steel bushings that extend through the two inner links only. As the chains break over the idlers and sprockets, the pins rotate within the bushings. In driving these chains, the teeth of the sprockets press against the bushings, so that wear is confined to the steel parts. The chains can be adjusted for length by turning a few of the eccentric pins, which are held in either of two positions by lugs on the sides of the links engaging cotter keys.

A complete tuyere unit from the dead plate to the retarding bar at the rear is shown in Fig. 5. As previously stated, the tuyeres are cast in short interchangeable sections containing varying percentages of air space, so that they can be placed at any position in the length of the grate, depending upon the air requirements. Each tuyere terminates in short vibrating bars that slowly rise above and then drop below the chains. In the upper position they stop the movement of the fuel and hold it back on the active grate, while in the lower position they permit the chains to carry the refuse to the ashpit. These rocket tuyeres, or retarding bars, are actuated by eccentrics *D* fastened to the belt-driven shaft *E* in Fig. 1. Adjustment of the travel of the rocker tuyeres is effected by means of the lever *F*. It may take place all above the top surface of the chain, entirely below, or in varying proportions partly above and partly below this level. Each eccentric and adjustment lever governs the rocker tuyeres for about three feet of the furnace width. This arrangement sectionalizes the fuel bed so that each section of grate can be treated individually to conform to any unusual conditions arising in that section. The thickened fuel bed makes possible the use of uniform windbox pressure and, in preventing holes in what would otherwise be the thin part of the fire, increases the percentage of CO_2 obtainable and the over-all efficiency of the furnace.

Drippage through the grate is minimized as the individual air openings are comparatively small so that the percentage of air space is reduced over natural-draft practice, and

FIG. 4. DETAIL OF LINK CONNECTION

the higher air velocity through the spaces prevents the small particles of coal falling through.

The chain elements are driven by sprockets keyed to a single shaft extending across the stoker. For narrow stokers this shaft rotates in two bearings mounted in the hopper frames, while for wide stokers one or more additional bearings are supported on center frames.

The shafts of the sprocket are driven by an eccentric and ratchet through a nest of spur gears. The wider stokers are equipped with gear nests on either side, and very wide units may be driven by two eccentrics and ratchets, one on each end of the shaft. Chain tension is adjusted by the take-up bolts *B*, Fig. 1. These bolts move the bearing boxes in an arc about the main driving pinion, so that the driving gears remain in mesh.

As the chains move down through the furnace, they are supported by cast-iron skids that bridge between the transverse steel members of the stoker. These skids also serve as supports for the tuyeres and are provided with ample openings for admission of the necessary quantity of air to the grates.

After the chains leave the lower skids, they ride on cast-iron idlers in rounding the turn. The idlers are larger in diameter than the sprockets, they are spaced by means of spools and are free to turn about the idler shaft. After turning around the idlers, the chain elements pass through air-sealed tunnels and then are supported on pipe rollers during the remainder of the travel.

Double Seals Prevent Leakage

Air for the stoker is admitted from a chamber extending beneath the entire grate that serves as a windbox and drippage pit. At the rear of this chamber there is a concrete wall on which is mounted a series of cast-iron tunnels through which the returning chains pass. Each tunnel is made up of two seals with an opening between that communicates to the atmosphere through duct *G*, Fig. 1. The advantage of this arrangement is apparent, because the pressure tending to force diluting air into the furnace is only the difference between the furnace draft and atmospheric pressure. With a single seal the full windbox pressure would operate to cause leakage. The seal is completed by a transverse channel, steel baffle and special design of that portion of the skids and tuyeres immediately above the tunnels.

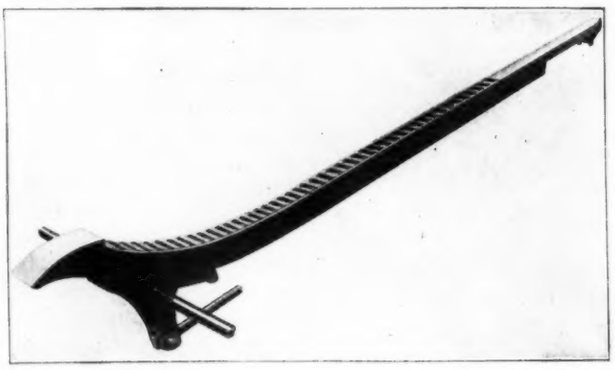
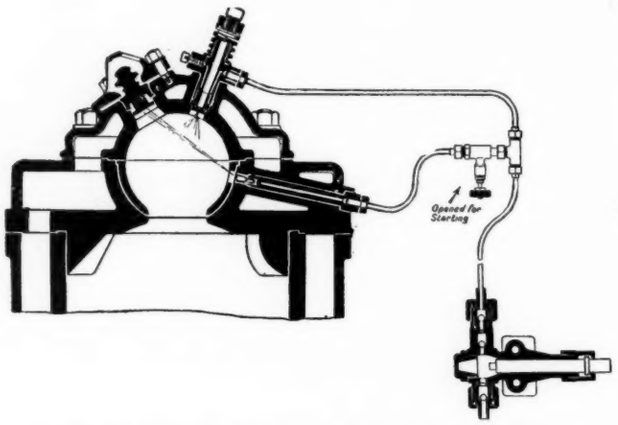


FIG. 5. COMPLETE TUYERE UNIT

The Plenty Oil-Engine Combustion

Few American or foreign builders of semi-Diesel oil engines retain the old form of combustion space. It was the prevailing belief for many years that a hot, uncooled surface, such as a bulb or plate, was necessary to insure ignition. The development of the dry, or water-injectionless, engine led to the adoption of a separate combustion chamber located in the cylinder head. The frequency of fractures in the head from improper cooling compelled the water-jacketing of the entire combustion space. The walls no longer contained sufficient



COMBUSTION CHAMBER OF THE PLENTY ENGINE

heat to raise the temperature of the cylinder charge to the ignition point, and the compression pressure was then increased to about 250 lb. per square inch.

The cylinder head illustrated is employed on the Plenty semi-Diesel engine, manufactured at Newbury, England. The combustion cavity, spherical in shape, is formed by the two parts of the cylinder head. The head is entirely water-jacketed, the water passing from the cylinder jacket at the head joint. To insure positive ignition, a cast-iron shell is placed in the lower half of the combustion chamber. Since this shell is cooled only through contact with the cylinder head, it attains a fairly high temperature.

To secure the first explosions upon starting, a steel plug is placed at the top of the combustion space and is held in place by a ring. Two injection nozzles are fitted into the cylinder head and connected to the pump discharge. On starting, the fuel passes through the nozzle at the side of the head and strikes the plug, which has been heated by a torch. After the engine has warmed up, the needle valve is closed and the oil is forced through the main nozzle at the top of the head. The oil is sprayed downward toward the opening to the cylinder.

The starting plug remains quite hot, since it is uncooled. On low loads, when the ignition is somewhat faulty, the auxiliary nozzle can be used, the fuel spraying onto the starting plug. It is a somewhat less cumbersome arrangement than is usually found on semi-Diesel engines.

Often the cylinder joint blows when a semi-Diesel engine begins to fire. It should not be assumed that the gasket is ruined; tightening up the nuts will often stop the leaks. It is always advisable to retard the pump plunger stroke until the engine comes up to speed.

EDITORIALS

Where All Is Confusion

FORTUNE does not smile upon all of us when we are born, and so some start their careers comparatively handicapped. The young man without college training or the equivalent entering power-plant work on the operating side and determined upon it as a career, is invariably "stumped" by the overwhelming, confusing variety of machines, endless piping, miles of wire, gages, instruments and apparatus. If the plant happens to be one serving a large office building or hotel, the situation for him is at first seemingly impossible of comprehension. Steam lines, water pipes, hot and cold and of various pressures, vacuum lines, heating pipes, brine pipes, ammonia lines—all in unending confusion, under, over and through buildings, machinery and numerous apparatus, each performing a different function. A three-ring circus or an income-tax blank to be filled are simple in comparison.

The mind of an ambitious young man, particularly here in America, is somewhat like a jitney bus—it wants to get there in a rush and miss nothing on the way. But this cannot be done. Nevertheless, the young fellow speeds on and eventually changes his method of attack and succeeds, or throws up his hands in despair and finds a job selling ribbons or as helper in a garage.

He has not learned that while there is an interdependence among the maze of equipment he sees, the whole is nothing more than a number of individual systems, each complete in itself and, after all, not terribly complicated. It is unfortunate that such young men do not have this pointed out to them by some of the older engineers in the plant.

What Are You Doing To Save Coal?

A COUPLE of years ago, when the demand for fuel was enhanced by the forced rate at which all industries were being run and the fuel supply was limited by shortage of man power and lack of transportation facilities, strenuous efforts were made to save fuel. The high price demanded for coal even under governmental price regulation inspired such efforts, but a more compelling force was the intimation by the agents of the Fuel Administration that the man who wasted coal would be the first to have his supply cut off when apportionment became necessary.

Under this spur and through the suggestions of committees of professional and practical engineers very considerable savings were made by ordinary precautions and simple expedients within the reach of the ordinary engineer or manager of a power plant.

With the termination of the stress of war conditions and the disorganization of the Fuel Administration there has been a serious let-up. The reins have been loosened, effort has been relaxed, and many plants have relapsed into their old slipshod methods of keeping going at any cost and without much if any attention to what that cost may be.

The engineer who can give an intelligent report of what it costs to run his department is the exception.

And yet the price of coal is higher than ever, and the threat of shortage in some sections of the country is so serious as to cause widespread alarm.

It is as essential as ever that the best possible use be made of every pound of coal; essential to the sections whose supply is threatened, essential to make more difficult the machinations of the pirates who profit by the necessities of others.

What are you doing to save coal?

Do you really know how much you are burning, what you are doing with it and how your results compare with those of others whose conditions are similar or reducible to your own? Have you coal scales, water meters, steam-flow meters, draft gages, pyrometers, CO_2 recorders, etc., so that you can tell how much coal you burn, how much steam it makes, what kind of steam it is, how much air are you heating unnecessarily and sending up the stack? Have you indicated your engines and pumps and seen that the valves and pistons were tight, have you trapped discharges from the system and have you seen that the traps were working properly?

We should welcome contributions telling what engineers have done to save coal and to record the results of their efforts, and we pay for those which are usable in our columns.

The Oil-Engined Central Station

THE ever-rising fuel costs and increasing wages have served to make even more perplexing the financial problems of all public utilities, both corporately and municipally owned. Few even of the most intelligently managed central stations have been able to avoid deficits during 1919 and 1920. The municipal light and water plants are, as a rule, deeply mired. Fortunate, indeed, is the management that can even meet operating expenses without regard to overhead charges, which in the main must be taken care of by tax levies in those localities.

On page 615 appears the record of the Miami, Oklahoma, municipal light and water department for the month of May, 1920. This represents very fairly the average monthly balance sheet. This plant meets not only all operating costs, but fixed charges as well. In fact, after taking care of all charges on an excessive investment representing the cost of the discarded plant, there is a substantial balance remaining.

The results obtained are not due to any exceptionally favorable load conditions nor to unusually high rates for current and water. The plant is an example of the efficiency that can be secured by proper selection of prime mover. The oil engine possesses certain characteristics, such as no stand-by losses, high thermal efficiency and an excellent low-load fuel consumption, that make its selection for light and water plants especially advantageous.

Synchronous Motor-Generator Frequency Changers

WHEN alternating-current systems are to be operated in parallel, there must exist between them a similarity of voltage phase and frequency. Voltage and phase change can be obtained through static transformers, but a change of frequency can be accomplished commercially only through rotating machinery, usually a synchronous motor-generator set.

As long as each locality or industry was supplied by its own power system, the question of frequency was not of serious importance and a large number of frequencies came into use, varying from sixteen to one hundred and thirty-three cycles. But when the economies to be realized by interconnecting power systems began to be appreciated, the frequencies of the various systems became of vital consideration, since wherever a difference of frequency existed it necessitated the installation of special machinery which to a certain extent nullified the benefits to be obtained from interconnection. This has very forcefully brought home the necessity of a standard frequency and has resulted in the elimination of practically all frequencies in this country except twenty-five and sixty cycles. Due to the interconnection of large power systems frequency changers have become an important part of many power-plant equipments. Therefore the article on "Operation of Synchronous Motor-Generator Frequency Changers," by M. W. Smith, in this issue, will be of interest.

In the distribution of alternating current there is, in general, a prejudice against the use of rotating machinery, largely on account of the simplicity of the static transformer, which may be operated for long periods before requiring attention, while a frequency-changer set requires an attendant. With the latter the efficiency is also lower, being around ninety per cent, compared to ninety-eight or ninety-nine per cent for the static transformer. However, where power is supplied from a frequency changer, the conditions existing in the load are not reflected back into the main system as when static transformers are used. Where the power factor of the load supplied from a frequency-changer set is low, the only machine on the system that is affected is the generator of the set; but with static transformers, the wattless current would be transmitted all the way back to the generating station unless corrective devices were used out on the system. Furthermore, the motor of the set will also correct for power factor, even if the only adjustment made is to regulate the field current to give unity power factor at full load. Such a load would improve the power factor of the system, and if the load is reduced on the motor it will automatically begin to supply a leading wattless current to the system to neutralize the effect of an equal amount of lagging current.

Where large blocks of power having low power factor are being supplied from a system of fifteen thousand volts or less and it is desired to correct the power factor, there are cases where a synchronous motor-generator set can compare economically with the static transformer. By using the motor-generator set, the transformers will be eliminated (which will amount to a large percentage of the cost of the set), the low power-factor load will be isolated from the main system, and the motor driving the set may be capable of correcting largely the lagging wattless of the main system.

Do We Want a Fool-Proof Machine?

IN a technical magazine there appeared recently an advertisement which in large type set forth a claim of "a fool-proof machine." Proceeding, the advertisement explained the automatic and continuous operation of weighing and proportioning the materials to be mixed in the equipment. All of this raises a question of the extent to which we can safely go in this direction.

Anything that savors of absolutely automatic operation is generally regarded as undesirable. In order to offset undue dependence upon automatic features gages or indicators of some type are very often put in such positions that the operator must actually go near the machine or device in order to read them at the intervals required. This judicious placing of indicating devices at what would otherwise be inconvenient locations should not be overlooked. The operator who gets to regard a machine as a thing which will go by itself and which he can forget, is reaching a dangerous frame of mind.

Let us by all means save human labor by making our devices as nearly automatic as may be practicable, but let us not go too far in eliminating the intimate supervision and the vigilance upon which safe plant operation depends.

Another Coal Dope

THIS time it comes from Denver and the claims made for it are even more than ordinarily brash. Listen!

COALSAVER is a powder which in a moment's time is dissolved in a little water and sprinkled over the coal. It is a wonderful combination of minerals which at a certain heat produces oxygen. This oxygen combines with the gas in coal and consumes it all, leaving nothing but a small percentage of slate or ashes.

It is a well-known fact that when coal is burned under ordinary conditions as much of the heat stored in it goes to waste up the chimney or smokestack as remains to be utilized. When COALSAVER is used the dampers or drafts are shut off once the fire is under way, thus keeping all the gases in the stove. COALSAVER gradually consumes these gases, which are the real vitality of heat-producing energy in the coal, and thus utilizes the enormous amount of heat which ordinarily is wasted. Everyone knows that air is required to burn coal, and so quite naturally wonders how the fire can be made to burn when the dampers are shut off. Right here is the secret of COALSAVER—it supplies this air in its purest form and in exactly the proper amount.

It would take 2⅔ tons of oxygen to burn a ton of coal if the coal were pure carbon and every atom of the oxygen got into combination with some of it. It is proposed to furnish this nearly three tons of oxygen or its equivalent by dissolving the contents of a dollar package of powder in water and sprinkling it over the coal.

To supply this 2⅔ tons of oxygen 11.520 tons, or 285,696 cubic feet, of air is required—enough to make a cube about sixty-six feet large, and you get the equivalent of all this in a dollar package.

It will save one quarter to one-half your coal, give a hotter, brighter, cleaner and more cheerful fire and do away with clinkers, soot-shaking and dirty work. All that is needed now is to put in a pinch of some other secret and mysterious chemical to make it shovel out the ashes and put the teakettle on.

And a lot of poor simps are falling for it.

CORRESPONDENCE

Where Should the Beginner Start?

On page 402 of the Sept. 7 issue of *Power*, C. F. Dewey's article relates to starting the beginner where he can learn to do his own repair work. It would be a wonderful help to the young engineers, water tenders and firemen, but it is not essential for the fireman because he is not generally called upon to make repairs. His job is to produce the maximum volume of steam with the minimum amount of fuel.

He does not always do so, however, for about nine out of every ten firemen fire as if the coal pile had no bottom. These men have never had any supervising as to how to produce steam with economy. I have found from experience that it is necessary to spend hours explaining the method of proper firing and the draft that will meet the requirements of the load with the least fuel.

How many engineers know what draft they carry or what drafts they should have for the grade of fuel being used? If they did they would go into the boiler room and spend hours with the firemen explaining the different drafts to meet the different requirements of the various loads. If you were to ask a man what his over-all and boiler efficiencies were no doubt he would put them high enough, and if you were to inquire as to how much excess air was being admitted he would doubtless take an oath that the settings were absolutely tight. The settings may have been tight at one time, but the question is, Are they tight at all times? That is what counts. If you inquired as to the condition of the baffles no doubt you would be told they were in first-class shape. But I venture to say if they were looked at while the furnace was in operation plenty of leaks would be in evidence. Such cases are too prevalent.

The fireman is the biggest problem we have to deal with. He can be wasteful or he can be saving. He handles a large sum of money in the form of coal. He handles it with a shovel, getting all of the dollars through the furnace door that he can and letting the small change mix with the ash instead of sending it to the bank to be credited to the company's account.

I would start the beginner for the boiler room in the boiler room and with a man who knew how and could produce high efficiency. Then by the time he is well broken in he will understand all the appliances and will begin to like the work. I have had firemen that have started in the engine room and I will admit that they have been failures in the boiler room, but by re-entering the engine room they have made good.

Latrobe, Pa. R. M. JENNINGS.

Pit Holes in Feed Pipe

In the issue of Sept. 28, page 514, W. A. Wallace asks for information regarding pit holes in feed pipes to boilers.

I have had some experience with pitting in pipes to boilers, which has been traced to free carbonic-acid gas in the water. This has caused brass pipes to disintegrate, but not nearly so fast as steel, either galvanized or black. Wrought-iron pipe also has given trouble in similar locations. Cast iron has been more or less free from it, and in one or two cases we have substituted cast-iron pipe for steel with very good results.

The best results, however, were obtained through the use of an open feed-water heater, which allows the free carbonic-acid gas to escape through the vent.

In this case I imagine it would probably be impossible to replace the closed heater by an open one, and I would suggest the placing of a pocket reasonably close to the heater where the gas can rise, and the installation of an air separating valve such as is used on forced circulation of hot-water systems, to free the line of the carbonic-acid gas and therefore prevent this doing any serious damage.

I am not positive that this will eliminate the trouble, but I believe it will go a long way toward it.

Boston, Mass HENRY D. JACKSON.

I would advise J. A. Wallace to cover his feed pipe between the feed pump and the boilers with asbestos or magnesia. This will prevent the cold air coming in contact with the hot pipe. Unequal temperatures are the chief cause of pit holes coming on the pipes. Unequal temperatures will shorten the life of any pipe, whether it is steel or iron.

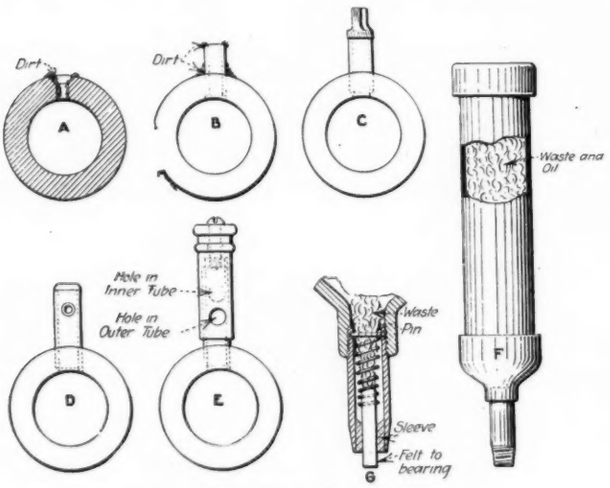
If the pump is not in good working condition it will either go too fast and flood the boiler, or sometimes when the fireman shuts off the steam to slow it down it will stick, and if the check valve or the pump discharge valves are not tight the water at over 300 deg. temperature will leak from the boiler back through the pump.

The best way to maintain an equal temperature in the boiler-feed pipes is to run the feed pump fast enough to keep a steady water level, and then the feed water will have a chance to get heated to a uniform temperature at all times. I advise putting in two check valves and a new set of pump valves, also a pump governor. Then, if the feed pipe is covered, the trouble will be ended. PATRICK MALLOY.

New York City.

Protecting the Oil Hole

Even on high-class machinery provision for oiling many of the bearings is by a countersunk hole, as shown at *A*. A straight hole would be bad enough, but the countersinking really makes it worse by providing an enlarged lodging place for dirt, which will continually find its way into the bearing. An inexpensive



TYPES OF BEARING OILERS

improvement on this is to drill out the hole and screw or drive in a brass tube or length of pipe, as at *B*. There will then be much less liability of the dirt getting into the bearing, and still less if a wood plug is fitted into the end of the tube as is usually done as shown by *C*. It is easy to plug up permanently the end of such a tube, as at *D*, and drill the oil hole on the side, giving still greater protection from dirt, at least as compared to the open tube, and furthermore, there is no plug to lose.

The final improvement in the improvised oiler is shown by *E*, where a cap is slipped over the tube and a screw put into the inner-tube plug to prevent the cap from being taken off. A hole is drilled in the cap lower than the one in the tube, so that the latter must be lifted to apply the oil can spout.

When an open bearing is located in an inaccessible place, with plenty of room above it, it is a good plan to screw a pipe nipple into the box, then a reducer and a large pipe nipple and a cap, as at *F*. The large pipe is stuffed with waste and oil poured in, which will slowly find its way into the bearing.

A further refinement is to plug up the lower end of the nipple with a brass plug drilled for a felt wick. A spring retained by a pin driven through the upper end of the nipple forces the wick against the shaft (see *G*), the action being similar to the wick oiler found on small electric motors. H. H. PARKER.

Oakland, Cal.

How Can Shavings Be Burned with Coal?

I have charge of a power plant where there is a considerable quantity of shavings to burn. The factory mill makes enough shavings in a day to run the power plant about five hours. When I took charge of the plant, the shavings were shoveled into the furnace by hand, although there was a shavings chute with connections to the boilers. The cyclone that receives the shavings from the mill is on the boiler-room roof, and just below is a shavings vault with a bypass to run them either into the vault or directly under the boilers.

By connecting the piping and feeding shavings directly under the boilers from the cyclone, more coal was used than when the shavings were shoveled by hand. By feeding in this way, it was thought to do away with opening the firedoors for long periods. The air blowing under the boilers with the shavings made matters worse. After two days' running it was necessary to shut down to roll the leaking tubes of the horizontal return-tubular boilers in use.

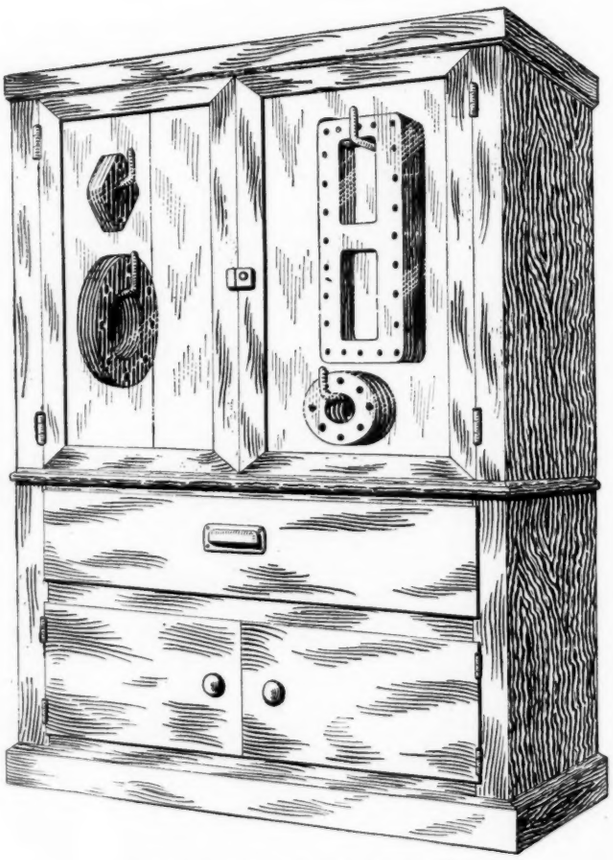
Can any *Power* reader suggest a remedy?

I should be glad to know how other plants burn shavings direct from the cyclone. Information from engineers who have had experience in burning shavings will be appreciated. ERNIE SCHATZ.

Racine, Wis.

Cabinet for Emergency Gaskets

There is perhaps not a power plant in the country that has not met with an emergency blowout where everybody rushes madly about trying to get the line



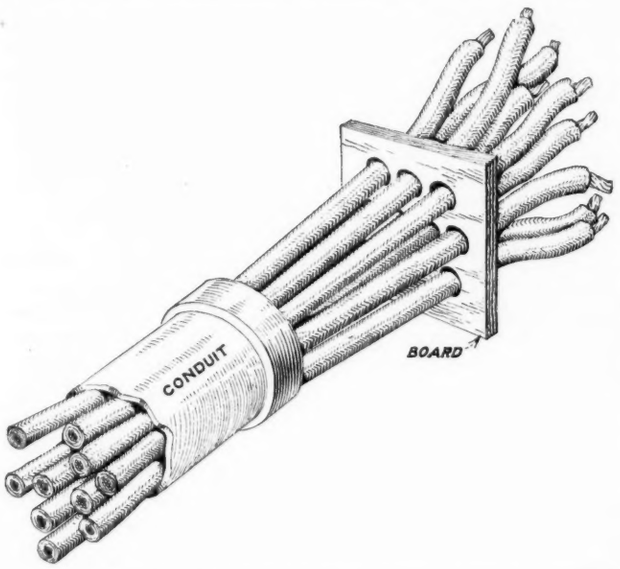
HANDY ENGINE-ROOM CABINET

back into service. I recently stepped into a plant where they had provided a large double glass-door cabinet wherein were hung in plain sight, with a sign on each, a new gasket for each important steam joint on the main lines and feeders. The idea is shown by the illustration. CHARLES H. WILLEY.

Concord, N. H.

Method of Keeping Wires Straight When Being Pulled Into Conduit

Where a number of conductors are being pulled into a conduit, such as for the connections between a controller and its resistance or motor, from a field-rheostat dial and operating mechanism on the switchboard to the resistance located some distance away, etc., the problem of keeping the wires straight and properly laid up dur-



ARRANGEMENT OF CONDUCTORS WHEN BEING PULLED INTO A CONDUIT

ing the pulling-in process is always present. I have found the scheme illustrated in the figure one that solves the problem very nicely.

In a piece of board a number of holes are bored, and through these the wires are passed and then connected to the pull-in line. When the wires are connected the board can be held away from the end of the conduit by a man while the wires are being pulled. Since the holes in the board hold the conductors in a given position on entering the conduit they will maintain this position throughout the latter's length. This greatly facilitates cabling up as the wires occupy practically the same relative position in each end of the conduit. When they are tested out the top conductors at one end will be found on top at the other and the bottom conductors at one end on the bottom at the other, which is seldom the case excepting where some means is provided to hold each wire in a given position in the cable. W. A. HARRIS.

New York City.

Static Electricity in Belts

In our plant there are a number of belts that are highly charged with static electricity. There has been considerable discussion among the members of the operating force as to just what effect this static will have upon the operation of the motors. I contend that, outside of being annoying to work around, these static charges will not affect the motors in the least. Some of the others claim that static charges in belts will cause the insulation on the motor windings to break down, but cannot recall any specific case where this has occurred.

I would like to have the opinion of some of the readers of *Power* on this matter. Is there an actual case on record where it is known specifically that static electricity in belts has destroyed the insulation on electrical machinery, and also what is the best way of overcoming the static charge? B. A. BRIGGS.

New York City.

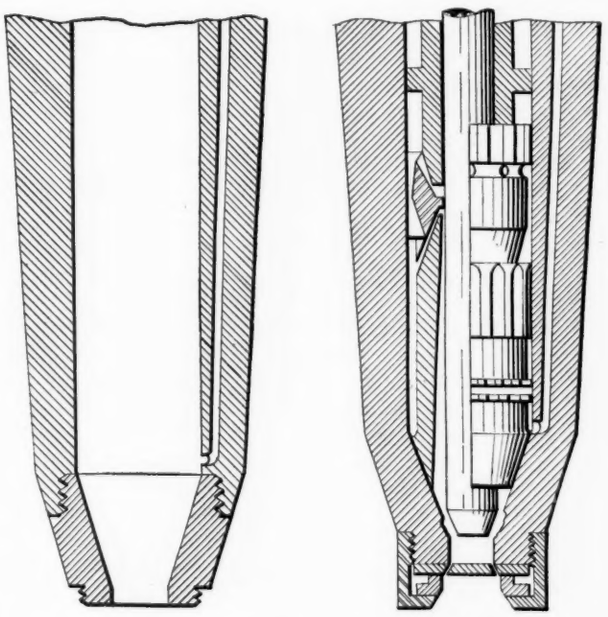
Repair of Diesel Fuel Valve

With the closed-nozzle type of fuel valve the needle often scores the seat. Minor scores or cuts can be removed by grinding. If the valve seat is very rough, it may be repaired by re-reaming. Frequently, the wear is so very rapid that constant reaming finally allows the tip of the needle valve to protrude and strike against the flame plate.

It is impossible to fully determine what causes the rapid cutting. Some engineers, thinking the spring compression too high, have slacked back the adjusting screw. The valve then apparently cuts as fast as before. Evidently, if the spring resistance is not high, the needle valve chatters on the seat when closing. If the spring compression is high, the valve seats with a blow, but does not chatter. There is, evidently, a point in the adjustment of the spring where the cutting effect is at a minimum. This can be determined by trial.

When the valve-cage seat has worn to such an extent that the needle valve tip protrudes, some engineers discard the cage and obtain a new one. At a small expense an engineer recently repaired several fuel-valve cages, making them fully as serviceable as new ones.

In Fig. 1 appears the McIntosh & Seymour fuel valve and cage, showing where the valve seat began to cut.



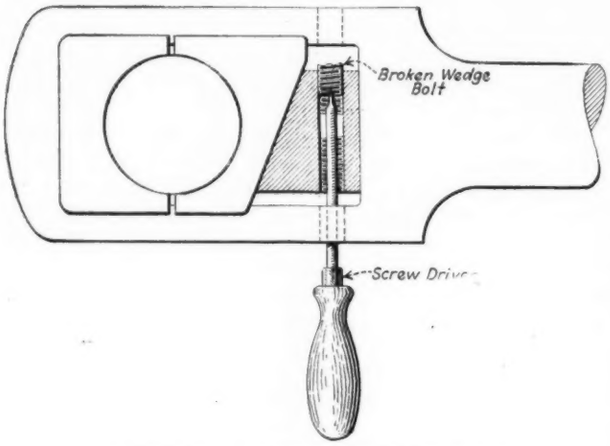
When the valve functioned no longer, the cage was removed from the engine. The end was cut off, bored and threaded. A tip was turned out of steel and screwed into the cage, as shown in the drawing to the left. This repair enabled the operator to avoid the purchase of a new cage. The cost of repairing was about five dollars, if the engineer's time be charged to the job. H. LONG.

Dallas, Tex.

Removing a Broken Wedge Bolt

In H. Hamkens' article on "Steam-Engine Operation and Maintenance," page 96 of the July 20 issue of *Power*, he mentions the trouble of removing wedge bolts when broken off short in the wedge. Drilling the wedge bolt and backing it out with a reamer requires time, and usually the housing has to be removed first to make room for the drill, which requires more time.

After the wedge bolt is machined and threaded, a groove can be cut crosswise of the threaded end of the



REMOVING A BROKEN WEDGE BOLT

bolt with a hacksaw, or in large wedge bolts it can be done in a shaper, the depth and width of the groove depending on the engineer's judgment.

Then if the top bolt should break off short in the wedge, the bottom wedge bolt can be removed and a screwdriver or a piece of flat steel, finished on one end to fit the groove in the end of the top wedge bolt, can be passed up through the hole in the connecting rod and the broken wedge bolt backed out, and vice versa in case the bottom bolt breaks.

Humboldt, Ariz. H. J. BAKER.

Engineers' License Laws

Discussions regarding engineers' license laws are of more or less interest to engineers. Some believe that such laws are necessary, and others are of the opinion that they are useless. Some hold that a license law is mostly a means of preventing the possibility of an overproduction of engineers; others are convinced that it is the only means of protecting the public from the results of accident.

As I understand it, the intent and purpose of the license law, as originally conceived, was to protect the public against boiler explosions. That in itself was commendable, because innocent workmen and others passing by the plant might be exposed to injury if the boiler plant were in charge of an incompetent man.

It stands to reason that the boiler attendant should be familiar with the operation of a boiler and have a general knowledge of its construction. Naturally, too, the engineer in charge of the plant should understand boilers, their design, operation and upkeep. Further than that, why should an engineer be obliged to work under a license?

Suppose that a man seeks a position in a steam plant. If he can pass a satisfactory examination as to the care and management of the boilers, why should he be obliged to satisfy the examiner that he knows how to set the valves on the various kinds of engines that are being operated? The public is not concerned, and there would be no menace to them if the valves were so faultily set that the engine would almost as soon run backward as forward. In fact, it would make no difference to the public if the engine was loose in every bearing and its thumping could be heard a mile away.

Then an engineer is examined regarding indicating an engine and is supposed to know all about steam economics. But these do not interest the public. Why, then, the necessity of an examination? The present-day engineer is also supposed to know all about motors and generators, but the public would not be concerned if an engineer burned one up every hour of the day.

It is true that engine flywheels explode and that the damage is carried outside of the plant, but a license won't prevent a flywheel accident, and it is safe to say that more flywheels explode in plants operated by licensed engineers than in non-licensed plants. So the license does not protect the public in this regard.

Some may say that a licensed engineer is necessary to protect the employer against incompetent engineers. That the plant owner is benefited is doubtless true, but why should an engineer be made to pay a license fee so that the plant owner may be benefited? He should take the same chance when hiring an engineer that he does when he engages an efficiency engineer, and the Lord knows that he is taking a chance with the latter individual.

If a plant owner engages an incompetent engineer, it is his own fault if he does not find it out and get another man in his place. I do not see, however, why engineers should be taxed so as to guarantee that a competent man is applying for a job. Holding a license does not make a competent engineer in any event, and the condition of many plants in charge of licensed engineers proves that this is so.

If we are to have license laws let us not fool ourselves that they are enacted for the benefit of the public, because they are not. Every engineers' license law that I know anything about has been proposed by operating engineers under the guise of protecting the public, but in reality to keep the supply of engineers as small as possible.

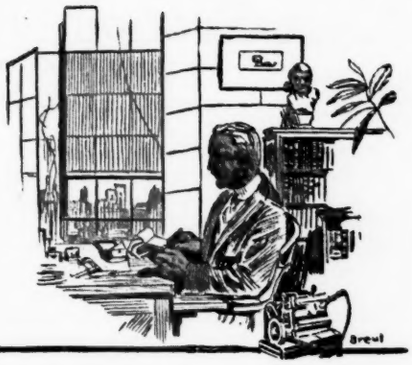
Legislatures have opposed such laws on the ground that they would be expensive and a tax on the public, and so the engineers agree to be fined in order to make the inspection department self-supporting, so that they can protect the public, who don't care a whoop one way or the other. It's a joke.

The employers in most cases oppose the adoption of a license law, but the operating engineers insist that they be licensed so as to prevent the plant owner from putting a $100,000 steam plant in charge of an incompetent man. In other words, they insist on paying a license fee in order to act as a guardian for the plant owner.

I hold a Massachusetts license. Therefore, I am not sore because I cannot get one, but it is my firm belief that the only reason that engineers have favored license laws is in order that they may feel more secure in their jobs, knowing that the harder the examination the fewer engineers there will be looking for their positions.

Boston, Mass. W. F. LOCKWOOD.

INQUIRIES OF GENERAL INTEREST



Proportions of Corliss Engine Cylinders—Why are Corliss engines made with cylinders longer in proportion to their diameters than in most other types of cutoff engines? J. R. F.

The speed at which an engine can be run with regular Corliss valve gear is limited to the time required for the various parts of the valve gear to adjust themselves and for the dashpot pistons to work properly; and to obtain a proper piston speed with the slow rate of revolution required, the stroke of piston and length of cylinder are made long in proportion to diameter.

Priming of Portable Boiler—What would cause priming of a threshing-engine boiler after about ten days' use with the same quality of fuel and of feed water? E. R.

The priming of the boiler may be caused by sediment accumulated out of the feed water, or carrying the water level so high as to afford insufficient steam room, or may be due to local violent boiling of the water from greater concentration of the furnace heat upon the heating surfaces of the firebox, caused by dirty fire tubes. Frequent washing out of the boiler and cleaning of the tubes will result in better quality of steam and improvement of fuel economy.

Advantage of Superheated Steam for Reciprocating Engine—How is advantage gained by the use of superheated steam for a reciprocating engine? G. L.

The principal advantage is derived from prevention of initial condensation. The higher the degree of superheat the drier the steam at cutoff, and by sufficiently superheating the steam supplied to an engine, it is possible to prevent any cylinder condensation and deliver dry or superheated steam during the exhaust. By using superheated steam, single-cylinder engines which are subject to large losses from cylinder condensation when supplied with saturated steam, may be operated successfully through a greater range of expansions and such an engine may be run economically with either a light or a heavy load.

Evaporation for Stated Number of Boiler Horsepower—What quantity of feed water must be evaporated per hour for development of 200 boiler horsepower capacity with steam generated at 150 lb. pressure and feed water at the temperature of 176 deg. F.? C. M.

A standard boiler horsepower is equivalent to the evaporation of 34.5 lb. of water from and 212 deg. F., or 34.5×970.4 B.t.u., per hour. Each pound of steam generated at 150 lb. gage, or 165 lb. per sq.in. absolute, contains 1,195 B.t.u. above 32 deg. F., and having the feed water temperature at $176 - 32 = 144$ deg. above 32 deg. F., each pound of the feed water would receive $1,195 - 144 = 1,051$ B.t.u. Hence, under the conditions stated, evaporation into dry saturated steam of $970.4 \times 34.5 \div 1,051 = 31.85$ lb. of water per hour would be required per boiler horsepower, and 200 boiler horsepower would require evaporation of $31.85 \times 200 = 6,370$ lb. of feed water per hour.

"High-Pressure" and "Low-Pressure" Steam—What is the difference between high- and low-pressure steam? L. B.

The higher the pressure of steam the greater its density, the higher its temperature and the greater the number of heat units contained per pound of heaviness. In other respects the physical characteristics of different pressures are identical. The designations "high-pressure" and "low-pressure" steam are purely empirical and vary in significance in different localities, establishments and operations. High-pressure steam generally is understood to apply to steam received directly from a boiler at high enough pressure for power purposes and without having sustained a reduction of pressure by passage through an engine, pressure-reducing valve or heating apparatus; and "low-pressure" steam generally is applied to exhaust steam or to steam that has been used first-handed in an engine, or steam whose pressure is not high enough for use in a non-condensing engine, or whose pressure has been lowered by passage through a reducing valve or in the performance of some useful operation.

Current-Capacity of No. 18 Copper Wire—What is the minimum length of No. 18 B. & S. copper wire that can be connected across a 110-volt circuit and have the temperature of the wire remain within a safe limit? A. F.

A safe temperature limit is rather indefinite, since for one set of conditions it would be one thing and something else for another. If fibrous insulation is used on the wire, the temperature would have to be limited to about 200 deg. F., while with asbestos it could easily be double this value. If the wire were run in open air, it would carry a considerably higher current without overheating than when wound in a coil. If insulated with cotton and wound into a coil, the current should be limited to a value where the watts expended in the coil would not exceed the coil's outside area, in square inches, times 0.75. This value will vary with the shape of the coil. If the wire is run in open air, it will carry approximately 10 amperes continuously without overheating and would require a length of about 1,600 ft. to limit the current to this value on 110 volts.

Polyphase Wattmeter Reading—A switchboard polyphase watt-hour meter is connected through two potential and two current transformers on a 2,300-volt three-phase circuit. If the potential transformer and current transformer connected to one of the meter elements are removed from the circuit, what percentage of the load would the other meter element register? W. T. L.

When a polyphase watt-hour meter is correctly calibrated and connected to a balanced three-phase circuit operating at unity power factor, each element will register 50 per cent of the power transmitted. If the power factor is less than unity, or the load is unbalanced, then one element will record more than 50 per cent and the other will record less, but the sum of the two in all cases will equal 100 per cent. From the foregoing it is evident that if one of the meter elements is disconnected and the load is balanced at unity power factor, the other element will record 50 per cent of the power transmitted. But under any other condition the registration of one element will depend upon the circuit conditions.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Some Economic Considerations in Design of Power Plants for Steel Mills*

By T. E. KEATING
Power Engineer, Westinghouse Electric and Manufacturing Company

IT IS the purpose of this paper to indicate in a general manner some of the important economic considerations that enter into the design of a power plant for a modern steel mill with particular reference to the utilization of blast-furnace gas and the efficiencies and costs that may be expected to prevail in such an installation. It is not intended to discuss matters external to the power plant any more than necessary to determine the fuel supply and power demands. For this purpose certain assumptions have been made.

The plant is to consist of four 500-ton furnaces and mills requiring an average load of 15,000 kw. to be maintained 20 hours per day for 310 days per year. Four hours per day of this same period the load will be 9,000 kw., while for the remaining 55 days of the year a load of 6,000 kw. will be required for the continuous operation of the blast furnaces, cranes and repair work.

To take care of these load conditions two 10,000-kw. units will be required a greater part of the time, and a third is installed as a spare, so that the power-generating equipment will consist of three 12,500-kva. 0.80 power factor 60-cycle 6,600-volt turbine-generator units. With the load demand outlined, the annual station load factor will then be approximately 40 per cent.

One of the first conditions to be determined is the steam pressure and temperature satisfactory for a plant of the type under consideration. The average steam pressure that has prevailed in the mills using reciprocating engines is about 140 lb., while in some large central stations power companies are satisfactorily using pressures as high as 300 lb., and three stations operating on 350 pounds.

Trend Is Toward Higher Pressures

The trend in steam practice is toward higher pressures rather than extreme superheat. There are two reasons for this: First, a practical consideration that with present-day materials it is more difficult to design equipment to withstand continuous operation on high temperature than on high pressure; second, a thermodynamic fact that for any definite total temperature of steam the amount of heat available for conversion into work when expanding to a certain vacuum is greater for high pressure and moderate superheat than for lower pressure and correspondingly higher degree of superheat. For example, if a total temperature of 600 deg. F. is desired with 150-lb. pressure, there will be required 234 deg. of superheat, and if expanded adiabatically to 28.5-in. vacuum there will be available for conversion into work 388 B.t.u. With the same total temperature of 600 deg. and a pressure of 350 lb., only 164 deg. superheat will be required, and if expanded through the same range, there will be 426 B.t.u. available for work. To obtain this latter value of 426 B.t.u. with 150 lb. pressure, there would be required 386 deg. of superheat, which is equivalent to a total temperature of 752 deg. This means that to obtain the same amount of energy available for work, a steam temperature of 752 deg. would have to be obtained and equipment designed to withstand it if 150-lb. pressure were used, while if 350 lb. were used a total temperature of only 600 deg.. with equipment to correspond, would be required.

The quality and quantity of cooling water, pumping head, cost of treating water, cost of maintenance, as well as initial cost of equipment, all have some bearing on determining the proper type of condenser for a particular installation. A summary of the relative values used for this problem is given in Table I. In evaluating the different types a fixed charge of 15 per cent on the respective installations is used, taking into account only the condenser equipment and necessary auxiliaries, assuming that the remaining power equipment and building will be identical for all types. However, in figuring the fuel costs it has been necessary to use the B.t.u. per kilowatt-hour for the complete installation, inasmuch as the amount of power required for air and condensate pumps varies with each type, and if turbine-driven auxiliaries are used the different amounts of exhaust steam affect the temperature of feed water and heat required per kilowatt-hour. With the surface-condenser installation the requirement at 15,000-kw. net station output, charging the station with power required for pumping from the river, auxiliaries for the condenser, excitation, boiler-feed pumps and blowers for boilers, is 24,100 B.t.u. per kilowatt-hour for 93,000,000 kilowatt-hours

TABLE I. COMPARATIVE ECONOMIC COSTS OF VARIOUS TYPES OF CONDENSERS OPERATING WITH THREE 10,000-KW. TURBINES

		Jet	Barometric	Surface
1.	Type of condenser			
2.	Water required; gallons per minute per unit	12,000	12,000	14,000
3.	Pumping head, in feet	44	64	56
4.	Installation cost of condensers, including air and condensate pumps and exhaust connections	$112,000	$78,000	$195,000
5.	Pumphouse cost, including screen and motor-driven pumps	135,000	137,000	138,000
6.	Water-treating plant, cost	65,000	65,000	12,000
7.	Total installation cost	312,000	280,000	345,000
8.	Fixed charges at 15 per cent	46,800	42,000	51,800
9.	Operating charges:			
	(A) Water-treating plant	17,000	17,000	2,500
	(B) Tube maintenance, including regular cleaning and complete retubing of 2 units in 4 years	.....	.....	10,000
	(C) Pump maintenance	2,000	2,000	2,100
10.	Total fixed and operating charges	65,800	61,000	66,400
11.	Fuel costs generating 112,000,000 kw.-hr. per annum	360,100	364,800	353,300
12.	Total items 10 and 11	425,900	425,800	419,700

per annum. The corresponding values for the jet and barometric installations are 24,600 B.t.u. and 25,000 B.t.u. respectively. The last two values are based on obtaining water from the condenser discharge wells for treating with a loss of only 8 deg. of temperature. If the condensers discharged back into the river, the B.t.u. values would be increased. The over-all economy was established at both 9,000-kw. and 6,000-kw. loads and evaluated for their respective periods, and the result is given in Table I.

Comparative Values of the Three Types

It will be seen that the final values for these three types differ from one another by only a small amount, and while the surface condenser is the most economical investment for the conditions assumed, there is not enough in its favor from the dollars and cents point of view to determine positively its selection if any local condition exists which makes its installation undesirable. However, in addition to the considerations tabulated there is another item in favor of the surface condenser; that is, the conservation of heat in the condensate. With a jet or barometric condenser this heat is generally lost in the circulating-water discharge and, if charged against either of these installations, would amount to between $5,000 and $6,000 per year. However, in computing the fuel charges for Table I it is assumed that with either a jet or barometric the water for the treating plant is taken from the condenser discharge well and that there is only 8 deg. loss in temperature.

The charge for condenser-tube maintenance assumed is much in excess of any data available, but is used so that there may be no indication of favoring the surface type. If comparative data were available, there should properly be some charge against the jet and barometric types for boiler tube maintenance. Even with water treatment, deposit is carried over into the boilers, limiting the rating and increasing the heat loss due to blowdown.

*Abstract from a paper presented at the Fourteenth Annual Convention of the Association of Iron and Steel Electrical Engineers, held in New York, Sept. 20 to 24, 1920.

Inasmuch as there are no local conditions prohibiting the use of a surface condenser and, in addition to the financial advantage already shown, the boiler operation will be materially benefited by its installation, further consideration of the station is based on the use of this type of condenser.

In order to maintain the vacuum specified each turbine exhausts into a 17,000-sq.ft. condenser circulating 14,000 gal. of water per minute.

Turning to the thermal economy, steam drive for the auxiliaries up to the point where the exhaust can be absorbed in the feed water costs about 3,500 B.t.u. per hp.-hr. of auxiliary power. However, such auxiliary turbines as exhaust to the atmosphere may require from 35,000 to 100,000 B.t.u. per hp.-hr., depending on the economy of the turbine used. Such auxiliary power as is developed by steam that is to be returned to the feed is obtained in the most efficient manner, while such power as is developed by steam exhausting into the atmosphere is obtained in the most extravagant manner. As it is impossible to have all auxiliaries driven by individual steam units and be able to utilize the exhaust at all station loads, it is necessary to consider other means of obtaining power for the auxiliaries.

Such auxiliaries as are driven by motors off the station bus operate on a B.t.u. cost equal to that of the main generating unit plus the losses in lines, transformers and motors. That is, if the main unit is generating power at a cost of 24,000 B.t.u. per kw.-hr., the cost of auxiliary power is approximately 28,000 B.t.u. per kw.-hr. or 21,000 B.t.u. per horsepower-hour.

The Blowing of the Furnace

While it is desired to limit this paper to a discussion of power problems, the blowing of the furnaces is so closely allied that it will have to be included. Turbo blowers have given such satisfactory service that they undoubtedly would be considered in this plant, and the blowers should be in the same operating room as the generators and take steam from the same boiler room. Therefore, in calculating the steam consumption of this plant, four 40,000-cu.ft. per minute blowers with four 5,000-sq.ft. condensers are included.

Table II gives an estimate of the steam consumption for this station and is based on five 1,500-hp. boilers operating at 170 per cent of rating. In calculating the boiler-feed

TABLE II. ESTIMATED STEAM CONSUMPTION ON 15,000-KW. LOAD ON TWO UNITS AND FOUR 40,000-C.F.M. BLOWERS WITH AUXILIARIES*

	Total Steam per Hour
1. Net station output; 15,000 kw. on turbine generators—2 units	186,000
2. Turbo-blowers—4 units	101,000
3. Circulating pumps serving condensers for generators and blowers	9,700
4. Air and condensate pumps serving condensers for generators and blowers	2,700
5. Excitation	1,300
6. Induced-draft fans	30,800
7. Forced-draft fans	1,400
8. Station lighting and for house-service pumps	700
9. Total items 1 to 8	333,600
10. Makeup; boiler blow-off, leaks, etc., 8 per cent	27,000
11. Sum of items 9 and 10	360,600
12. Boiler-feed pumps	9,000
13. Contingencies	11,000
14. Total demand on boilers	380,600
15. B.t.u. in auxiliary exhaust 40,990 × 1,190 =	48,600,000
16. B.t.u. in condensate, 311,900 × 55 =	17,130,000
17. B.t.u. in make-up, 27,710 × 38 =	1,055,000
18. B.t.u. total items 15 + 16 + 17 =	66,785,000
19. Item 18 ÷ Item 14 =	175 deg.
20. Boiler-feed temperature = 175 deg. + 32 deg. =	207 deg.

* All auxiliaries motor-driven, except boiler-feed pumps and induced-draft fans.

pump requirements, it is assumed that two out of four 500-g.p.m. pumps are operating. While it would be possible to carry this load more economically on one pump of larger capacity, it is well to have considerable leeway in capacity of pumps operating on a variable load. The resulting feed temperature of 207 deg. is, of course, subject to variation a few degrees one way or the other, and is probably so high that steam might be lost on swinging load. In order to have this factor under control, it is therefore recommended that instead of putting in a larger pump resulting in less steam consumption and correspondingly lower feed temperature, that with an installation of four pumps there be two steam-driven and two motor driven.

By a computation similar to Table II a feed temperature of 210 deg. is obtained at a station load of 9,000 kw. if two steam-driven feed pumps are operating, and at 6,000 kw. a temperature of 194 deg. with one steam-driven pump.

In order to determine the amount of gas available, a coke rate of 2,000 lb. is assumed, resulting in 140,000 cu.ft. of gas per ton of coke, and a heat value of 95 B.t.u. per cu.ft. With four 500-ton furnaces operating, this is equivalent to 1,110,000,000 B.t.u. per hour. Allowing an availability factor of 80 per cent to take care of loss of gas during tapping, poor gas and irregularities in supply, a value of 888,000,000 B.t.u. is obtained. Allowing 30 per cent for heating stoves, there is available for blowing the furnaces and power purposes 622,000,000 B.t.u. per hour. Four blowers and auxiliaries require 134,000 lb. steam per hour, which with 76 per cent boiler efficiency and 207 deg. feed water, is equivalent to 196,000,000 B.t.u. per hour, or 22 per cent of

TABLE III. ESTIMATED COST OF POWER PLANT FOR STEEL MILL, INCLUDING THREE 10,000-KW. TURBINE GENERATORS AND FIVE 40,000-C.F.M. TURBO-BLOWERS

1. Excavations and foundations	$500,000
2. Building of structural steel and brick	400,000
3. Boilers; eight 1,500-hp., including superheaters and brickwork	650,000
4. Stacks and breeching	100,000
5. Gas cleaners, piping and burners	300,000
6. Stokers, fans, shafting and air ducts	120,000
7. Induced- and forced-draft fans	75,000
8. Coal storage, crane, ash handling	50,000
9. Feed-water heaters	15,000
10. Feed and water power-house service pumps	20,000
11. Water-treating plant	12,000
12. Turbine generators and air washers	640,000
13. Turbo-blowers	650,000
14. Condensers for generating and blowing units, including pumps and exhaust connections	300,000
15. Pump house, including screen and pumps	150,000
16. Piping and covering, steam and water	320,000
17. Exciters, motor-generator set, switching, house transformers	125,000
18. Gages, flow meters, laboratory equipment, etc	25,000
19. Crane	15,000
20. Construction-plant equipment	20,000
21. Total	$4,487,000
22. Contingencies—5 per cent	224,000
23. Total	$4,711,000
24. Engineering and supervision—10 per cent	471,000
25. Total	$5,182,000
26. Interest charges on portion of capital required during construction—5 per cent	259,000
27. Grand total	$5,441,000

888,000,000 B.t.u. This leaves 426,000,000 B.t.u. per hr. available for power generation, which at the rate of 24,100 B.t.u. per kw.-hr, is equivalent to 17,700 kw. net station output.

Looking at the gas supply from another angle, assume that at the time of tapping, when gas from only three furnaces is available, there is an availability factor of 90 per cent and the stoves require 30 per cent, leaving 523,000,000 B.t.u. per hr. for blowing and power. A power load of 15,000 kw. will require 362,000,000 B.t.u., and three blowers under load, with the fourth running light, will require 155,000,000 B.t.u., giving a total of 517,000,000 British thermal units.

Exact Balance Between Gas Supply and Power Demand Impossible

Of course such an operating condition as an exact balance between gas supply and power demand is a practical impossibility, and it will probably be necessary to burn coal under one boiler a greater part of the time. For this station it is suggested that eight 1,500-hp. boilers be installed, the average load to be handled by five units at 170 per cent rating, while 20,000 kw. load will be carried on six units at the same rating. All boilers would be equipped for burning gas and four for burning coal. It is not intended that the boilers should burn coal and gas simultaneously, but that four boilers would ordinarily burn gas and one burn coal, and enough boilers should be equipped with stokers to carry the load in case of loss of gas.

In Table III is given an approximate estimated cost of an installation such as has been outlined. It is understood that the various items are intended to indicate the relative rather than the absolute costs and may be subject to considerable variation, depending on the location of the plant, the type of equipment bought and the method of installing it. Costs of excavation and foundations may readily differ 100 per cent in various locations. The total figure, which is the most important, represents a fair estimating cost for such a plant under present-day conditions.

Out of the total cost of $5,441,000 approximately $3,600,000 is chargeable to the electric-power plant. This cost of $120 per kw. represents a fair price under present conditions. Some central stations with refinements to obtain the highest economy, machine shops for repairs, and switching for operation on systems of large capacity have run as high as $150 per kilowatt.

Assuming 15 per cent fixed charges on $3,600,000 and 112,000,000 kw.-hr. per year, the kilowatt-hour cost for fixed charges is 0.481c., or practically half a cent per kilowatt-hour.

Using the fuel charge of $353,300 per annum, as given in Table I, this is equivalent to 0.315c. per kw.-hr. for fuel alone, based on charging blast-furnace gas equivalent to coal at $3.50 per ton. If $5 coal is used, this figure for fuel becomes 0.45c. per kw.-hr. The fuel cost in stations of this type is usually between 75 and 80 per cent of the total operating cost. Using a factor of 75 per cent, the operating costs per kilowatt-hour for $3.50 and $5 coal are respectively 0.42c. and 0.6c. Adding these figures to the fixed charges mentioned gives total power costs of 0 9 and 1.08c. per kilowatt-hour. That is, the fixed charges and operating costs are approximately equal and power may be expected to cost about one cent per kilowatt-hour when generated in a station of the type outlined.

When the paper was presented there was considerable discussion on the question of a central power station for large steel mills, it being maintained by some that this was the solution to the steel-mill power problem. However, others took the view that there was greater insurance of continuity of service if the power plant was divided into two or more units located at advantageous points in the works. One case was referred to where all the power generating equipment was located in one central station and that trouble with boiler-feed pumps, in one instance, had practically caused a shutdown in the station. Since that time arrangements have been made to install a second plant at another location in the works.

It was considered a good plan to use waste-heat boilers and turbines located at the open-hearth furnace. Objection was raised to long high-pressure steam lines since they gave considerable trouble and the maintenance costs were high.

Placing the fixed charges at 15 per cent as in the paper, caused considerable difference of opinion. These were placed as high as 25 per cent by some, it being generally conceded that probably 20 per cent would be a fair average value at the present time.

Test for Softening Point of Fireclay Brick

The American Society for Testing Materials has adopted as standard the following test to determine the softening point of fireclay brick, by comparison of test cones with standard Orton pyrometric cones heated in a suitable furnace:

A 1-kg. (2-lb.) sample shall be taken by chipping off approximately equal portions from the corners of the brick. These fragments shall be reduced in size by means of rolls or a jaw crusher adjusted to pass a lump 6 mm. (¼ in.) in diameter. They shall be mixed thoroughly and the amount of material reduced to about 250 g. (5 lb.) by quartering. A magnet shall be repeatedly passed through the crushed material until all particles of metallic iron are removed. This portion shall be ground in a porcelain or agate mortar to pass a 60-mesh Standard sieve. In order to avoid excessive reduction of the fines, they shall be removed frequently during the process of reduction by throwing the sample on the sieve and continuing the grinding of the coarser particles until all the sample will pass through the sieve.

The sample thus prepared shall be thoroughly mixed and, after the addition of sufficient dextrine or glue and water, shall be formed into test cones in a metal mold in the shape of tetrahedrons measuring 5 mm. (⅜ in.) on the sides at the base and 25 mm. (1 in.) high.

When dry the test cones may be subjected to a preliminary burn at a temperature not exceeding 1,300 deg. C. (2,372 deg. F.) for the purpose of sintering them into a firm condition to permit handling.

The test cones shall be mounted on plaques of refractory material of such a composition as will not affect the fusibility of the cones.[1] They shall be mounted with the base embedded approximately 1 mm. (0.04 in.) in the plaque and the face of one side inclined at an angle of 75 deg. with the horizontal. The arrangement with respect to the Orton cones shall be substantially as shown in Fig. 1; that is, alternating with the Orton cones in such a way that Orton

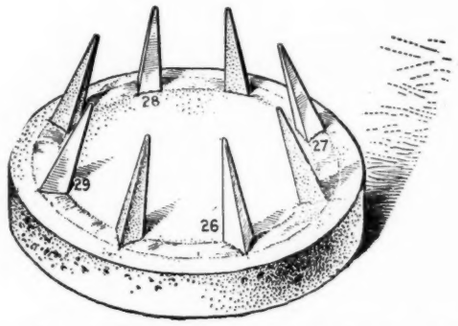


FIG. 1. ARRANGEMENT WITH RESPECT TO ORTON CONES

cones of successive numbers will be placed opposite each other. The plaque may be any convenient size and shape and may be biscuited before using if desired.

The heating shall be done in a suitable furnace at a rate not greater than 15 deg. C. (27 deg. F.) per minute, nor less than 10 deg. C. (18 deg. F.) per minute after cone No. 1 is reached, or as nearly within these limits as possible.

That type of furnace in which a neutral or oxidizing atmosphere may be maintained is to be preferred. Excessive reducing conditions should be avoided. Care should be taken that the flame does not strike directly against the cone or cone plaque. The furnace should be tested at intervals for the determination of the uniformity of the distribution of the heat.

The softening of the cone will be indicated by the top bending over and assuming the position shown in Fig. 2.

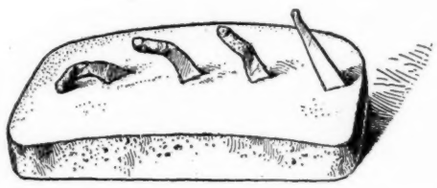


FIG. 2. INDICATING SOFTENING OF THE CONES

The bloating, squatting or unequal fusion of small constituent particles should always be reported. The softening point shall be reported in terms of Orton cones and shall be that cone which most nearly corresponds in time of softening with the test cone. If the test cone softens later than one Orton cone but earlier than the next Orton cone and approximately midway between, the softening point shall be reported thus: Cone No. 31-32.

If the test cone starts bending at any early cone but is not down until a later cone, the fact should be reported.

[1] A mixture of equal parts of a highly refractory clay, such as a good grade of china clay, and fused alumina which will pass a 100-mesh sieve has been found satisfactory.

The construction of a power plant capable of developing 350,000 hp. the year-round may be a direct result of the passage of the Federal water-power bill. This new plant will be located at Priest Rapids, on the Columbia River in eastern Washington, and the development of this immense hydro-electric power plant will cost around $150,000,000, including the construction of manufacturing industries and of irrigation systems that will reclaim thousands of acres of the surrounding land.

Smoke Prevention Association Holds Annual Convention in Chicago

AFTER a lapse of two years the Smoke Prevention Association convened from Oct. 5 to 8 for the fourteenth annual convention at Hotel Sherman, Chicago. An interesting program dealing with industrial, railway and domestic smoke had been prepared. The attendance was exceptionally good and representative of the various branches of the field. Tuesday morning was taken up with registration and the usual brief addresses of welcome. At the first professional session on Tuesday afternoon, Nathaniel B. Wales spoke on "Smoke Prevention in Stationary Plants." He said that very little progress had been made in the design of settings for fire-tube boilers. In the usual design of return-tubular boiler three factors were of importance in getting the best results. There must be secondary air admission to the zone back of the bridge wall and turbulation to thoroughly mix the air and the volatile, with sufficient heat in the refractory to maintain the mixture above the critical ignition temperature of the gases. The speaker would accomplish this by means of a specially designed checkered bridge wall, of which no detail was given.

In discussing the practical side of smoke prevention L. R. Pyle said that the first essential was an honest interest and determination to prevent smoke, and that this determination must start at the top of the official family. At least 90 per cent of the smoke reduction should result from education. The men must be taught how first, and then properly supervised, with a follow-up system to make sure that they do not slow up in their work. The city should provide schools to educate the firemen and have a staff of experts to demonstrate efficiency methods. There should be very close co-operation between city and railway smoke inspectors. The best results cannot be obtained unless the equipment is maintained constantly in excellent condition.

In a paper on "Chimneys and Chimney Draft." Thomas F. Clark mentioned more types of stack than most of the listeners thought existed. He dwelt briefly on the well-known types such as steel stacks, guyed and self-supporting, concrete stacks with their reinforcing steel, common brick and radial brick stacks and even wooden stacks such as are used in certain chemical industries. The principal requirements of good design were reviewed, and some attention was given to losses of draft in the stack, flue and through the boilers. The total drop determines the height of stack necessary, and the velocity of the gases, which should be about 30 ft. per second, as well as the volume, determines the area at the top. Some interesting information was given relative to the movement of high stacks such as are employed in smelteries to carry away the acid fumes, and the necessity of keeping these gases at a high temperature so that the acids will not condense in the stack and cause deterioration.

Industrial Day

Wednesday, Industrial Day, brought out a number of interesting papers. Dr. E. Vernon Hill, chief sanitary inspector of Chicago, suggested a solution of the municipal-smoke problem. Reference was made to burning coal in the home and the long process from the mines to the basement furnace, accompanied by an increase in cost for the fuel of 75 to 100 per cent. With the arrival of the coal the trouble is only beginning. The coal is dirty to handle, is burned at an efficiency ranging from 20 to 65 per cent and produces such quantities of smoke and soot as to cause impairment of public health and deterioration of property. Fundamentally, the whole method is wrong. As an improvement Dr. Hill suggested that the City of Chicago obtain the properties of the gas company and add byproduct ovens so that all domestic coal coming to the city could be treated or distilled to recover the by-products. The gas could be turned into the mains as usual, and the semi-coke that was left distributed for smokeless domestic fuel. Although years must pass before such a scheme could be thoroughly worked out, it is entirely feasible and practicable. The byproducts would much more than pay for the recovery, and the gas and coke could be sold cheaper than the present supply of either.

To simplify the solution suggested, the smoke association and all other engineering organizations should father a plan to advance the block plan of heating. If a central plant was installed to supply an entire block or perhaps several blocks, the best equipment could be installed and the operation would be economical. Such an arrangement would make the basement clean and dispose of the unsatisfactory janitor service. Even with the recovery plant in operation, it still would be necessary to distribute the coke, and the latter problem would be lightened, owing to the reduced number of plants that would have to be supplied. The plan has been held back by the general apathy of the public, but it would be of interest to state that surveys are now going on in certain blocks on the north side, so that the coming winter may see block plants in operation in Chicago. It was the final suggestion of the speaker that the various engineering societies should first carry on the fight against a smoky city; second, foster and encourage the block plan of heating; and third, distribute educational propaganda for a city gas plant to be operated as outlined. When accomplished this would mean a smokeless city, improvement in public health and a saving of $2,000,000,000 in fuel throughout the United States.

Pulverized Coal in Power Plants

Perhaps the most interesting paper of the day to power-plant operators was a talk on the use of pulverized coal under power-plant boilers from the smoke-prevention standpoint, by Henry Kreisenger, formerly of the Bureau of Mines. He spoke of his work at the Oneida Street Station of the Milwaukee Electric Railway and Light Co., for which the Combustion Engineering Corporation is furnishing the funds and the Bureau of Mines the trained men and instruments necessary. For awhile thirteen men were employed and there are now five on the job. The first question on which the testing force concentrated was the amount of solids or ash going up the stack. As is well known, the boilers are of the Edge-Moor horizontal water-tube type, vertically baffled for three passes. They had found that in general about one-third of the ash settled at the bottom of the furnace, another third in the combustion space below the second and third passes, and the final third found its way to the breaching and the stack. A considerable amount of this remaining third collected at the bottom of the smoke flue and at the base of the stack, only the finest ash floating out at the top of the chimney. By sending the final third of the dust that ordinarily reaches the stack through a cyclone separator, they had been able to collect 88 per cent of it, so that only 12 per cent of the final third of the ash floated out through the stack to the atmosphere. The ash was pulled out of the bottom of the furnace every twelve hours. It had thus been demonstrated to their satisfaction that the objection commonly offered to burning powdered coal under boilers, that of the ash going up the stack, could be successfully met without any great expense.

The character of the ash differs from that from a stoker or hand-fired furnace. The coal is ground very finely and when blown into the furnace a large part of the ash is in separate particles. Owing to the high temperature in the furnace, these particles fuse slightly and when leaving the furnace look like small molten beads of mineral matter, some of them transparent like glass, some white and some black. This is what looks like smoke when issuing from the stack, but is of entirely different composition. If a powdered-coal furnace is operating properly, there is no such thing as soot, but unfavorable conditions may cause

small globules of coke to float along with the beads, the amount of coke depending upon the furnace volume relative to the fuel burned and the quantity of air that is supplied.

To obtain the best combustion, the speaker said it had been found that 1½ lb. of bituminous coal per hour per cubic foot of combustion space should be burned. When it came to 2 lb. per cubic foot of furnace, there was difficulty in preventing coke formation. In the particles going up the stack they had found about 10 per cent carbon, when the excess air ranged about 10 per cent. The particles were from 0.0002 to 0.0001 in. in diameter. The draft in the breeching ranged from 0.06 in. to 0.1 in., and in the first pass there was practically atmospheric pressure. That there was little infiltration of air had been demonstrated by the small difference in analyses of the flue gases at different parts of the setting.

Questioned in the discussion as to the respective merits of coal distillation and recovery of byproducts versus the use of powdered coal, the speaker contended that he favored the former for low-ash coal. Coke with 15 per cent ash was fairly good fuel for domestic heating and metallurgical purposes, but to secure coke of this quality it was necessary to use coal with not more than 10 per cent ash. Roughly, all coal having less than 10 per cent ash was suitable for byproduct plants and coal having a greater percentage of ash should be burned raw in stokers or pulverized coal plants. Questioned as to the highest percentage of ash that would be permissible in a pulverized-coal plant and still give satisfactory commercial economy, it was the speaker's guess that coal containing up to 20 per cent ash could be used. The rating obtained from the boiler and the quantity of coal burned depended entirely upon the furnace volume. At the Oneida Street Plant they had been operating the boilers between 125 and 175 per cent of rating, to which they had been limited because of the comparatively small volume of the furnace. With Illinois coal containing about 12,000 B.t.u. per pound, they were getting an evaporation of 8½ lb. of water per pound of coal, with a steam pressure of 175 lb., superheat at 100 deg. and feed-water temperature of 100 deg. The coal entered the furnace at a velocity of about 60 ft. per second and passed out at 5 ft. per second.

H. A. Savage, of the Combustion Engineering Corporation, followed with an illustrated talk on several powdered-coal installations, mentioning in particular the Morris plant at Oklahoma City, where Texas lignite containing 11 per cent ash and 33 per cent moisture had been burned at an efficiency of 78 per cent.

Wednesday Afternoon Session

At the afternoon session Prof. A. C. Willard gave an extended and interesting talk on "Heating Boilers and Furnaces, Power Plant Design and Ventilation." The speaker emphasized the importance of excess air. By analyzing in detail the various losses that take place in the furnace and the boiler, he showed that the loss from excess air was proportionately large and it might easily amount to 10 per cent of the heat in the coal. In the average plant, depending of course upon the fuel used, from 15 to 18 lb. of air per pound of coal should be considered good practice rather than the 24 to 40 lb. so often used. There was no doubt that a decided saving could be made by reducing the excess air. In the first place it lowered furnace temperatures, was the cause of smoke and, as more gas than necessary was passing through the setting and the flues, a higher draft was needed to pull these gases through. With a greater differential between the pressure inside the furnace and outside, more air infiltrated through the setting and was the cause of a proportionate drop in efficiency.

In conclusion, the speaker discussed air leakage into buildings, the high cost of ventilation, and the effect of air in piping and radiators. The air leakage from natural causes was based on the lineal feet of crack around and between the window sills. At a wind velocity of thirteen miles an hour, which was taken as a fair average, the leakage amounted to 0.147 cu.ft. of air per minute per foot of crack per mile velocity of the wind. It was important to realize that as the wind increased the pressure varied as the square of the velocity, so that the leakage increased rapidly with the wind velocity. Calculations were made on typical buildings to show that this leakage was a big factor, warranting investment in weather strips or other means of stopping the cracks.

Thursday, Railway Day

Thursday was Railway Day, and a number of interesting papers in this field were presented. On Friday morning St. Louis was chosen as the next meeting place, the convention to be held early in June of 1921. The following officers were elected:

President, Joseph M. Lonergan, of New York; first vice president, W. A. Pittsford, of Kewanee, Ill.; second vice president, J. W. Burrows, of St. Louis, Mo.; secretary-treasurer, F. A. Chambers, of Chicago.

Throughout the convention entertainment was provided for members and visiting ladies in the way of automobile rides, theater parties and inspection trips to places of interest, such as the Municipal Pier, the big mail-order house of Sears, Roebuck & Co., and the Union Stock Yards. A trip through the parks, ending up in a dinner at the Marigold Gardens, was particularly enjoyed.

Kansas City Railways Plant Operation

The report of Robert P. Woods, city member, Board of Control, Kansas City Railways, as detailed in the *Electric Railway Journal* for Oct. 9, includes some facts of interest to readers of *Power*.

This report shows that the switchboard cost in 1920 was 1.2336c. per kilowatt-hour, compared with 1.3264c. in 1919; the average price of coal per net ton in 1920 was $3.64, compared with $3.74 in 1919; and the average price of oil in 1920 was $1.68 per bbl., as compared with $2.56 in 1919. The fuel cost per kilowatt-hour in 1920 was 8.86 mills, while the labor cost was 1.38 mills.

Particulars are given of efforts that are being made to bring up the temperature of boiler-feed water and to reduce the trouble caused by scale. According to the report considerable improvement has been made in the feed water temperatures, although the average is probably under 170 deg. F. Steps are being taken to install a bleeder connection between the third and fourth stages on the 15,000-kw. turbine and the auxiliary exhaust which passes close by the turbine. It is estimated that these connections will cost approximately $250. Check valves will be installed so that when the turbines are shut down or operated under light loads, no steam will flow from the auxiliary exhaust to turbine. When the turbines are operated at load, steam will be bled from the turbines into the auxiliary exhaust, enabling the water to come from the underfeed heaters at approximately 210 deg. instead of at 170 deg. Besides the heat gained by this arrangement, it is hoped to deposit approximately two-thirds of the scale-forming compound in the heaters instead of in the boiler tubes. This will be accomplished by raising the feed-water temperature in the heaters. Most of the carbonate scale will be deposited if the temperature is kept at about 180 deg., and it is estimated that at least two-thirds of the scale-forming compounds are carbonates.

The presence of scale and the large amount of boiler cleaning necessary have resulted in the loss of a considerable number of boiler tubes In combination with the bleeding scheme, the board's engineer recommended, and the suggestion is being placed in effect, that six boilers be used for purely evaporator service. Under this scheme all raw water will be sent to a certain group of boilers which will always be operated at relatively low ratings on account of the bad water conditions in them; all other boilers in the plant will then be fed from pure, condensed water.

No scale whatever would, therefore, exist in a great majority of the boilers in the plant, and a higher efficiency of heat transfer would result, making it unnecessary to waste heat for blowing down and avoiding delay for replacing any tubes. It is proposed to feed all raw makeup water to one of the small heaters on the north side of the boiler room.

Capacity and Maintenance*

By Charles A. Cahill†

The erroneous opinion seems to have spread abroad that central stations, such as serve the larger cities, must consume about all the fuel that is used in the neighborhood. This is far from being true as the great coal consumers of the country are the industrial interests at large, although none of the individual plants will approach in size and electrical output that of the public utility.

To illustrate, the public utilities of Wisconsin, electric and gas, exclusive of steam railroads, use in round figures, 10 per cent of the coal consumed. This percentage will not hold good for other states, but it is safe to say the total fuel burned by these utilities is a small percentage of the whole. In the development of these large central stations the design may be described as good, passable or indifferent, as is the case with plants in general. Following our national mania for "big things," we have been inclined to turn to the large central station as a model for all plants, large or small, without regard to the conditions of service demanded.

Fixed Charges Must Be Kept Low

In financing and in the design of the modern central station where the output is electrical energy only, with uninterrupted continuous service and low load factor, it is imperative to keep the fixed charges down to the lowest possible limit. This has been done largely by working the equipment to the limit during the hours of peak load. This practice may be considered correct for the central station except where it is not carried to a ridiculous extreme. But, because this is the best practice for this type of plant, it does not follow that the average industrial plant should have the same design or should be operated in the same manner.

The plan of operation previously outlined has been copied by some industrial establishments to their sorrow in maintenance costs, unreliable power, light and heat service and, worst of all, in the general demoralization of the power plant's operating crew. Efficient service from these men is of vital importance in producing first-class low-cost service. The present chaotic coal conditions, requiring in many localities the use of any quality of coal that the market affords, have complicated operation, and this is intensified when the men are handicapped with insufficient heating and grate surface for the ever-increasing steam demands. A 400 per cent boiler rating looks well on paper and can be obtained for a few hours with good coal. If this state of affairs becomes a steady diet, demoralization begins with the chief operating engineer and rapidly extends down the whole line. There is nothing so fatal to low power costs. As nothing "succeeds like success," so on the other hand, nothing demoralizes like more trouble continually piling up. The maintenance costs usually go up to an excessive figure in the boiler plant where the larger part of the operating costs is absorbed.

Sizes of Boiler Units

It is not possible to overload to such a degree the generating end of the plant unless electrical burnouts are invited. With the overrating that is now prevalent, generators and motors in a measure protect themselves. It was the writer's belief that boilers, stokers and auxiliary equipment should be operated at the point of their highest efficiency, and that the boiler units should be of such size as to give the greatest number of boiler hours possible to the plant as a whole. Large boiler units are all right for large stations, but some industrial plants have become so impregnated with this disease that when a boiler is taken out of service 50 per cent of the boiler capacity is eliminated.

A close observer will have noticed that things change in power-plant equipment after the fashion of spring styles in ladies' hats. Many of these things are put over by much advertising and efficient sales organizations rather than by sound engineering principles. One thing that has not changed is the fact that to get the results that the best-designed plants are capable of giving, requires the perfect teamwork of a well-trained operating crew led by an engineer who knows his business, both in theory and practice, and has executive ability and tact to get along with the management. Best results are impossible where operating conditions are maintained at the breaking point. Emergencies can be taken care of now and then, as occasion may demand, but with continuous performance at high pressure, men grow stale and good results fall off. Plant records prove this.

More Attention Should Be Given to Maintenance

Not enough attention is given to maintenance. A certain amount of money should be appropriated yearly to keep the plant in strong operating condition. The tendency to put things off until a future date is pernicious in its results, yet the practice seems to prevail in many plants. The difference between a successful operating engineer and a conspicuous failure, is that one keeps ahead of troubles in one case, and in the other the troubles keep ahead of the engineer. A man who has the foresight to anticipate what may happen and promptly rectifies a defect that would cause trouble is worth five times as much as the man who can patch a thing up after it smashes through actual neglect. Here again is where a plant that is pushed to the limit is at a great disadvantage. Repairs cannot be made thoroughly and are more or less temporary in character. This procedure always lowers the vitality of the plant. If a certain sum of money is annually provided for maintenance, it creates a much better impression with the management than a large lump sum required all at once, after a term of years.

Distinction is to be made between maintenance and so-called improvements. When it comes to the latter, some hard thinking is necessary. Improvements are justified, first, to increase the plant's safety, second, to increase its reliability, and third, to increase its economy. Many so-called improvements do not help in these directions, and at the end of the fiscal year there are large direct expenditures embarrassing to explain. When matters have been considered carefully and it is thought beyond any reasonable doubt that a saving of 6 per cent in operation can be made, it is better to guarantee the management a saving of 4 per cent. If the improvements show a saving of 8 per cent, so much the better.

Present Conditions Demand Careful Work

The present high price of coal and the demoralization of the country's transportation system call for the best possible work in power plants. These calamities have awakened a great deal of interest in the management of power-plant affairs that were formerly passed along unheeded and taken as a matter of course. Power-plant costs have become a serious thing and must be given attention. The competent engineer can now get a respectful hearing, which he always could have had in the old days if he had been able to express himself in a plain straightforward manner, always granting that he was sure of his ground. That there is a wide difference in handling maintenance matters is evidenced from the following examples:

Case one is where there is a fairly equipped repair shop for handling all maintenance except the heavy work on the largest machines. The crew make most of the renewals and apparently have no heavy repairs, as they are continually at work on some plant equipment. Everything is going along smoothly, and the plant's record for good service and high economy is excellent.

Case two is where the repair crew is on call as is practiced with a city fire department. Things are supposed to be done with a rush and always with a hurrah and a great deal of fuss. Like the fire department, they wait until the fire starts before there is anything done. The operating records show that in case one the costs are lower and interruptions in service from power-plant trouble are almost unknown.

*Abstract of paper read at the annual convention of the National Association of Stationary Engineers, Milwaukee, Wis., Sept. 13-17, 1920.

†Consulting mechanical engineer, Milwaukee.

One of the advantages the engineer has in a small plant is that he is in closer touch with his equipment and men at all times than one who has a large plant and organization. The maintenance of a good organization in a large plant is more of a task than to maintain the equipment. What may be expected with a given piece of equipment is known. On the other hand, little is known of the possibilities of the complex human beings that look so much alike in general but are so widely variable in their mental make-up.

The engineer who is anxious to make the best possible record must give more attention to human engineering than he has in the past. The only reason today that makes all engineers seem of so little consequence in public affairs is because they have been dealing with natural laws and materials to such an extent that the ever-important human factor has slipped away from them and has been worked to the limit by others.

A. A. E. Conference on Employment and Education

With a large attendance assured, the conference on employment and education sponsored by the American Association of Engineers, which will be held in the Congress Hotel in Chicago on Nov. 12, promises to be an inspiring meeting. All free employment bureaus and agencies are being invited, as well as representatives from engineering societies and engineering colleges. The purpose of the meeting is to consider the general problems of employment. The following subjects are not all that will be considered at the conference, but are merely those which have been determined upon definitely:

George P. Hambrecht, chairman of the Industrial Commission of Wisconsin, will speak on "Employment Office Administration and Technique."

A. B. Crawford, director of the bureau of appointments of Yale University, will deliver an address on "Placing the Graduate in His First Position."

A. B. McDaniel, development specialist in construction for the War Department at Camp Dix, will speak on "Educational Work for the Permanent Army."

Prof. Arthur F. Payne, chairman of the trade and industrial department of the college of education in the University of Minnesota, has selected as his subject, "Vocational Analysis and the Engineer."

James P. Munroe, vice chairman of the Federal Board for Vocational Education in Washington, will discuss "Vocational Advisement as a Prime Function of Educational Institutions."

R. O. Kramer, manager of the mechanical department of Montgomery, Ward & Co., of Chicago, will speak on "Engineering Opportunities in Large Mercantile and Mail-Order Houses."

A. A. Potter, dean of engineering in Purdue University, will speak on "Summer Employment for Men in Teaching Service."

The Coal Situation in Brief

According to the weekly report of the Geological Survey, Department of the Interior, the production of bituminous coal fell off sharply during the week ended Oct. 2. The total output (including lignite and coal coked) is estimated at 11,348,000 net tons, a decrease when compared with the preceding week of 506,000 tons, or 4.3 per cent. The cause of the decrease is not yet clear. Up to Thursday, Sept. 30, loadings were proceeding at a rate in excess of the previous week, but on Friday and Saturday they declined sharply. Analysis of the reports of the railroads shows that the decrease centered in the fields north of the Ohio and Potomac.

Production during the first 234 working days of the last four years has been as follows (in net tons): 1917, 417,141,000; 1918, 449,334,000; 1919, 352,794,000; 1920, 404,114,000.

The year 1920 is thus about 13 million tons behind 1917 and about 45¼ million tons behind 1918, but is 51½ million tons ahead of 1919. In this connection it should be remembered that production during 1918 exceeded consumption and provided for a net addition to consumers' stocks by the end of the year of approximately 30,000,000 tons. In 1919 this condition was reversed; consumption exceeded production and there was a net draft on stocks of perhaps 40,000,000 tons for the year.

Expressed in net tons, the dumpings over tidewater piers as reported to the Geological Survey by the Tidewater Bituminous Coal Statistical Bureau were 1,280,000, almost exactly the same as during the preceding week. Dumpings for New England account declined sharply, amounting to 203,000 net tons, or at the rate of 870,000 tons per month. Exports rose from 582,000 to 653,000 tons for the week, or at a monthly rate of 2,800,000 net tons.

Comparative Tests of Sulzer and Still Oil Engines

At the final meeting of the Liverpool Conference of the Institute of Naval Architects considerable attention was given to the results of a series of tests of a Sulzer Diesel and a Still steam-oil engine.

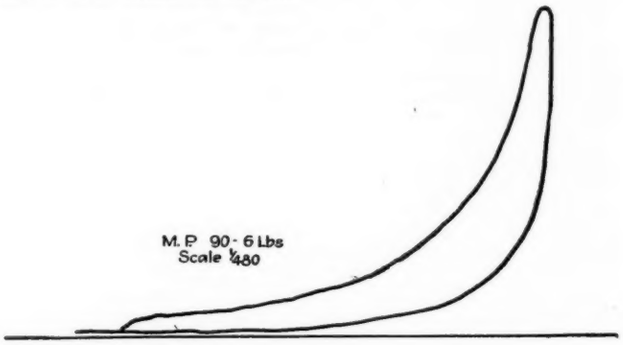


FIG. 1. INDICATOR DIAGRAM FROM SULZER ENGINE

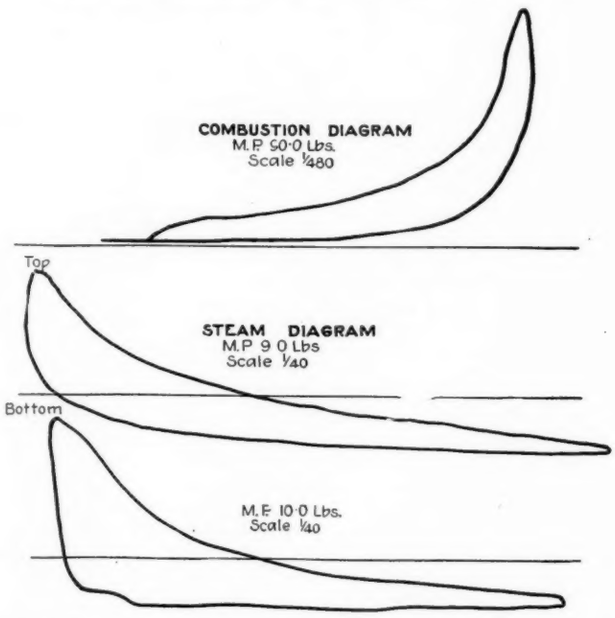


FIG. 2. INDICATOR DIAGRAMS FROM STILL ENGINE

The Sulzer Diesel is well known, and the Still engine has been described in numerous technical papers. In the Still engine the oil combustion acts upon one side of the piston while steam acts on the other side. A small boiler is a part of the equipment and absorbs the heat from the water gases of the internal-combustion side of the engine. The cycle of the steam portion of the engine is quite along

customary steam practices, a condenser, boiler-feed pump, etc., forming part of the equipment.

In the tests a small vessel was fitted with a set of Still engines of 250-hp. capacity. Tests as to thermal efficiency on shaft horsepower were run. These units were then removed and a Sulzer set installed. These engines were

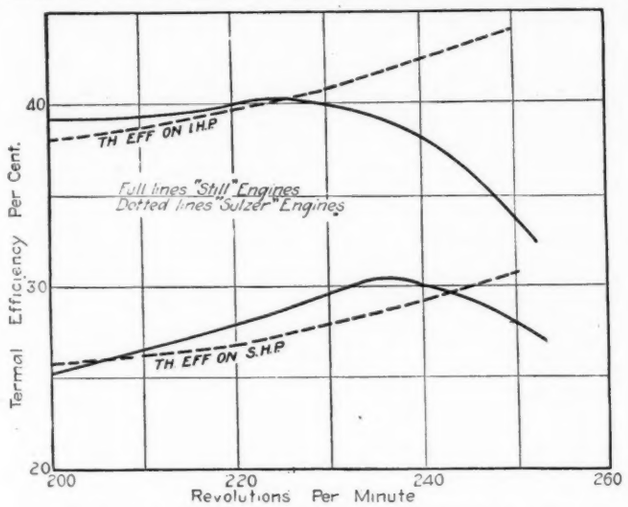


FIG. 3. THERMAL EFFICIENCY OF SULZER AND STILL ENGINES

tested while all conditions, so far as possible, were the same as during the Still tests.

A representative of each firm was present at the trials and was satisfied that the tests had been carried out in an approved manner. The oil used was shale of 0.85 gravity. —*Engineering.*

Water-Power League Holds Convention

That water-power developments are being intensively studied in many quarters was demonstrated beyond question at the convention of the Water Power League of America, in Washington, Oct. 7 and 8. The League is a new organization, and as it was founded by men who had not been identified in the water-power movement, it lacked the general appeal of an organization with established prestige. Nevertheless, the sessions were well attended. Each address was followed by discussion which indicated that a large proportion of those in attendance were studying carefully the problems of power development. Those interested in the super-power survey being made of the Boston-Washington area were particularly in evidence.

The sessions were presided over by Dr. George F. Swain, professor of civil engineering at Harvard University. Just prior to the convention Dr. Swain accepted the presidency of the League.

The convention, very apparently, gave the Water Power League additional impetus. Committees are to be appointed to make studies of various problems connected with the development of water power. It was announced that the organization is to be composed of operators of water-power projects and consumers of water power, in the hope that these interests may gather around the table and arrive at agreements that will permit the stimulation of water-power development and at the same time protect the consumers from excessive charges. It is the intention of Edward Terrill and Frederick L. Long, the founders of the League, to open a Washington office in the near future.

Addresses were made at the sessions by Dr. George F. Swain, president of the Water Power League; O. C. Merrill, executive secretary of the Federal Power Commission; Col. William Kelley, chief engineer of the Federal Power Commission; Alexander T. Vogelsang, assistant secretary of the Interior; John A. Britton, vice president and general manager of the Pacific Gas and Electric Co.; John W. Dorsey, of the University of Manitoba; and W. S. Murray, chairman of the Super-Power Survey.

The question of the possibility of improved method of mining our coal does not seem to be engaging the necessary attention. The late Sir William Ramsay, it will be remembered, maintained that it was practical to gasify thin coal seams *in situ*, a feat which would enormously increase our fuel reserves and might greatly reduce costs. His scheme did not commend itself as practicable to mining engineers, but some experiments were made, which, however, were impeded by his ill health and brought to an end by his death. In view of present developments it might be well if the committee would add to the list of investigations that they have now in hand a thorough inquiry into the practicability of Sir William Ramsay's schemes, forbidding though the attendant difficulties appear. —*Engineering.*

Manufacturers of Ontario, Canada, who will need electric power this winter, are facing a serious situation. The Ontario Hydro-Electric Commission has apparently contracted to supply more power than it is at present possible to develop, unless there is an early and abundant rainfall, or unless water is released from storage in the Trent watershed. This latter course, however, would be a gamble, as it would cause a worse shortage in case no rain should be forthcoming. It would also be likely to cause litigation with riparian owners who have an agreement as to the level at which certain lakes shall be kept. The Department of Railways and Canals is in charge of the water conservation of the Trent area, and seems to have a problem before it which will be difficult to solve.

In an address before the National Safety Council recently, D. J. Price brought out some interesting facts about dust explosions. He pointed out that dust explosions have taken place recently in several industries where the dust produced had not previously been regarded as dangerous. Explosions of this sort have occurred in starch factories, sugar refineries, cocoa and chocolate plants, spice works, paper mills, woodworking establishments, shoe factories and aluminum-ware polishing works. Special methods for the prevention of these explosions are being investigated by the engineers of the Bureau of Chemistry at Washington.

That power plants in the United States are not alone in their fuel-shortage troubles is indicated by a report from South Africa. Vice Consul Charles J. Pisar, of Cape Town, reports that the principal coaling stations in southern Africa are suffering from a coal shortage that is causing considerable delay to vessels calling at these ports for bunkers. This situation is entirely due to the lack of engine power and rolling stock on the railways, which handicaps the transport of coal from the mines to the coast.

The total production of coal in France during 1919 was 21,610,000 tons, as compared with 26,322,000 tons in 1918. It is estimated that the present monthly requirements are 5,600,000 tons and that in 1920 it will be necessary to import at least 45,000,000 tons from foreign countries. The amount of coal imported into France during 1919 and the first four months of 1920 was as follows, according to country of orgin: England, 15,300,000 tons; Belgium, 1,700,000 tons; Germany, 2,000,000 tons; total, 19,000,000 tons.

The international coal situation is discussed by Joseph A. Broderick, vice-president of the National Bank of Commence, in the October number of the bank's magazine, the *Commerce Monthly*. Mr. Broderick says that French industries are receiving but two-thirds of the coal they need to run at capacity. Norway is getting only half enough, Italy three-fifths, and the Netherlands about one-half of what is required.

The United States Department of Commerce reports that the export of coal from Swansea and Port Talbot, South Wales, has decreased from 401,824 tons in January to 249,844 tons in August. This decline was due to shortage in output at the mines and consequent limitation of export under control of the government.

I. C. C. Takes Measures to Relieve Middle West and Northwest

By canceling all outstanding permits for the use of open-top cars for purposes other than the transportation of coal and by modifying its order giving assigned cars to public utilities, the Interstate Commerce Commission has taken action which is expected to make possible a weekly coal production in excess of twelve million tons. The cold wave which struck the Middle West and Northwest early in October called forcible attention to the fact that householders had been unable to lay in their winter's coal. This gave rise to such a demand that it became imperative for the Commission to make possible the initiation of the distribution of domestic coal in that section. The minimum requirement was 2,000 cars daily. When the railroads were called upon to divert that number of cars from the Lake coal movement they declared it would be impossible under conditions which then existed. The railroads called to Washington representatives of the operators and of others interested.

It became quite clear after several conferences that action by the Interstate Commerce Commission would be necessary. This resulted in the Commission conducting a series of executive hearings, after which they issued Service Orders 20 and 21. There was great protest from the building industry and from other industries which were making use of open-top cars, but the Commission reached the conclusion that other industries would have to be without these cars, except when en route back to the mines, until navigation closes on the Lakes.

To administer the public utilities order, a committee of three has been named, made up as follows: W. L. Barnes, American Railroad Association; D. B. Wentz, president of the National Coal Association, and George W. Elliott, chairman of the National Committee on Gas and Electric Service. If a public utility needs emergency coal application should be made to this committee. The operators' representative on the committee will attempt to secure delivery of the necessary coal without invoking the service order. In case immediate delivery cannot be secured by that means the Interstate Commerce Commission then will provide that particular utility with assigned cars which will be set in at the most available mine.

The Oil Situation

Henry L. Doherty & Co., in their Investment Bulletin, state that since August, 1919, the oil industry has been facing an unprecedented demand for all petroleum products, with consumption running ahead of domestic production. The situation would be far more critical than it actually is were it not for the wide expansion that has occurred in imports from Mexico in the last eighteen months. The average daily consumption of oil in the United States since August, 1919, has been 1,159,016 bbl., against an average domestic production of 1,103,085 bbl. The Government reports show that in June, 1920, there was on hand but 20 days' supply of gas and fuel oil, but 418 days' supply of lubricating oil and 43 days' supply of gasoline.

The average daily consumption of gasoline increased 32 per cent in the first half of 1920 over the first half of 1919, being at the rate of 11,773,106 gal. daily. Consumption of fuel and gas oil rose to 22,013,227 gal. daily.

The "Aquitania," the second large liner to be converted into an oil burner, has been very successfully operated with fuel oil. On her first voyage since conversion 47,000 shaft horsepower was developed. When she used coal approximately 200 firemen and coal passers were required while now only 50 firemen are needed. The average rate of speed as an oil burner was $\frac{8}{10}$ of a knot greater than the vessel ever made as a coal burner, saving five hours between New York and Liverpool.

New Publications

EMISSIVITY OF HEAT FROM VARIOUS SURFACES. By V. S. Day. Bulletin No. 117, issued by the Engineering Experiment Station of the University of Illinois, Urbana, Ill. No charge.

This bulletin deals principally with an investigation of the value of insulating material commonly employed in warm-air furnace installations, as affecting the economy of the system. The results of the tests are convincingly illustrated by diagrams and tables.

BITUMINOUS COAL STORAGE PRACTICE. By Prof. H. H. Stoek. C. W. Hippard and W. D. Langtry. Bulletin No. 116 issued by the Engineering Experiment Station of the University of Illinois, Urbana, Ill. No charge.

This bulletin deals with the prevention of fires caused by spontaneous combustion in stored bituminous coal and gives the results of actual experiences with fires in storage piles. The safe storage of coal is becoming more and more necessary to relieve the congestion of transportation systems, which are overtaxed at one time and able to handle more at other times.

THE LOCOMOTIVE UP TO DATE. By Charles McShane. Published by Griffin & Winters, Chicago, Ill. Second Edition. Cloth, 6 x 9 in.; 893 pages; 376 illustrations. Price, $5.

The original work was published twenty years ago, and the advancement in locomotive practice is responsible for the many changes that have been made in this second edition. The text throughout has been revised and much of it has been rewritten in order to present certain subjects more fully or in a new aspect in accordance with recent developments in locomotive design and practice. The plain, commonsense language of the first edition is maintained in the second one, and the book is understandable to anyone who can read English. Over three hundred pages are devoted to valve gearings, going into the construction, advantages and disadvantages of one over another and the operating results. Special instructions are given regarding the link motion and as to valve-gear breakdowns and their remedies for each type of gear and the procedure in case of accident while on the road. Other subjects treated are the air brakes, superheaters, feed-water heating, blows and pounds and methods of accurately locating and remedying them. The volume contains much practical information that enginemen should know. The book is well illustrated and the text matter is presented in an interesting manner.

Personals

F. Van Buren Connell has accepted a position as sales engineer for the Automatic Fuel Saving Company, of Philadelphia, Pa.

Harry H. Bates has returned to the employ of the Westinghouse Electric and Manufacturing Company in the Stoker Engineering Dept.

Leroy P. Sterling, formerly with the Huasteca Petroleum Company, is now with the International Petroleum Company, Tampico, Mexico.

Wilford Y. Cannon has been promoted from assistant consulting engineer to chief engineer of the Utah-Idaho Sugar Co., Salt Lake City, Utah.

John S. Paul, formerly mechanical engineer, American Brake Shoe & Foundry Co., is now with The McCann-Harrison Company of Cleveland.

R. W. Leeper, formerly with the General Electric Co. in Cincinnati, Ohio, is now with the Management Engineering and Development Co., Dayton, Ohio.

Edward E. Lamberson has left the Manila Electric Co., P. I., to take a position with the Brooklyn Edison Co. as assistant steam engineer of the entire system.

J. P. Maloy, for about twenty-five years connected with the Lagonda Manufacturing Co., has recently formed the Chicago Engineering Co., of which he is the head.

C. H. Vickers is now designer and draftsman with the Moore Steam Turbine Corp., of Wellsville, N. Y. He was formerly with the Walworth Manufacturing Co., Kewanee, Wis.

J. R. Masferrer has resigned his position with the United States and Cuban Allied Works Engineering Corporation, to enter the Dodwells (Cuba) Ltd., Havana, as a sales engineer.

William S. Hill, formerly superintendent of the electric department of Springfield (Mo.) Gas and Electric Co., is now manager of the Arkansas Light and Power Co., Stuttgart, Ark.

D. G. McMillan, formerly with the Williams Printing Co., New York City, as maintenance engineer, has been appointed power superintendent with the Willys Corporation at Elizabeth, N. J.

R. D. Koplin is now assistant mechanical engineer for the Lehigh Valley Coal Company, Wilkes-Barre, Pa., having left the engineering department of the Atlantic Refining Company, Philadelphia Pa.

Charles H. Bromley, associate editor of **Power** for over eight years, is giving up this position to take up engineering and commercial executive duties with the Richardson-Phenix Co., Milwaukee, Wis.

Kneeland A. Mereness has accepted a position as instructor in the department of machine design at Cornell University. He was formerly with the Remington Typewriter Co., Smith Premier Works, Syracuse, N. Y.

George A. Evans is now with the Grasselli Chemical Co., Grasselli, N. J., as head of the power department. He was formerly assistant mechanical engineer, Public Service Electric Company, Newark, N. J.

Howard I. Holleman, formerly in the construction-engineering department of the General Electric Co., Schenectady, N. Y., is now with the Bethlehem Chile Iron Mines Company, Mina Tofo La Higuera, Coquimbo, Chile.

M. J. Dempsey has resigned his position as chief draftsman with the Chase Metal Works, of Waterbury, Conn., and is now connected with the Miamus Motor Works, of Stamford, Conn., in the capacity of production manager.

F. M. Bond, who for the past six months has been manager of the Corticelli Silk Mills (Nonotuck Silk Company) at Leeds and Haydenville, Mass., has been appointed general manager in charge of all the mills of the Company, with headquarters at Florence, Mass.

H. H. Couzens, manager of the Toronto Hydro-Electric Commission, has been appointed general manager of the combined Toronto Railway Co. and Toronto Civic railways, the appointment to take effect when the Toronto System is taken over as a civic enterprise next year.

Dr. Frederick H. Newell, for the last five years head of the department of civil engineering at the University of Illinois, has recently resigned his position, and Dr. Ira O. Baker, professor of civil engineering and for many years head of the department, has again been placed in charge of the department as acting head.

James A. Elliott, formerly chief accountant, Cooley & Marvin Company, Boston, announces that a partnership under the firm name of **Elliott, Davis & Company**, has been formed between himself and Herbert T. Davis, also of Cooley and Marvin Company. The new company will conduct a general practice of public accounting. The main office is in Boston; a branch office is located in New York.

Arthur Cutts Willard, professor of heating and ventilation in the department of mechanical engineering at the University of Illinois, has been appointed head of the department to succeed Dean C. R. Richards, who, since his election as dean of the College of Engineering and Director of the Engineering Experiment Station, has continued to serve as the acting head of the department of mechanical engineering.

Society Affairs

The Philadelphia Section, A. S. M. E., will meet on Oct. 25 to hear an address by Albert Kingsbury, Consulting Engineer, on "Bearings."

Metropolitan Section, A. S. M. E., will meet Oct. 22 to discuss the "Relative Advantages of Modern Steam and Electric Locomotives." Frank J. Sprague, consulting engineer, will make the introductory remarks.

The Engineers Society of Western Pennsylvania will meet in the William Penn Hotel, Pittsburgh, on Oct. 19. M. T. Montgomery, of the Pittsburgh Railways Co., will present a paper on "Stores Engineering."

The Boston Section of the A. S. M. E. is to make a visit of inspection of the Fore River Plant of the Bethlehem Shipbuilding Corp., at Quincy, Mass. The trip will start at the plant promptly at 2 p.m., Daylight Time, Oct. 19.

The Chicago Section of the American Welding Society has issued a little booklet, the title of which is "Keep the Guess Work Out of Welding." Copies may be had by addressing the American Welding Society, 608 South Dearborn St., Chicago.

The American Association of Engineers has granted club charters at Leavenworth, Kan.; Santa Cruz, Cal.; Amarillo, Tex.; Montreal, Canada; Wilmette, Ill.; Erie, Pa.; Warren, Ohio; Conneaut, Ohio; and Phillippi, W. Va. A chapter charter has been conferred in Cambridge, Ohio.

The National Executive Committee of the American Association of Engineers has approved the proposed bill for licensing engineers, architects and surveyors in Ohio, as presented by Cecil L. Rood, president of the Ohio Engineering Society and the Ohio Association of Technical Societies, and approved by the Ohio Assembly of A. A. E.

The American Society of Lubrication Engineers was organized recently in Chicago. The newly elected president is Nicholas Griffin, vice president of the Mack International Motor Truck Corp.; the vice presidents are Carver Wood, chief technician of the Wayne Oil Tank and Pump Co., Fort Wayne, and L. A. Stewart, of the Anderson & Gustafson Co., Chicago; the treasurer is J. B. Rathbun, consulting engineer on *Petroleum Magazine;* and the secretary is C. B. O'Hare, formerly with the Sinclair Oil Co.

Individual Members of the American Association of Engineers who are interested in furthering the interests of the Democratic and Republican political parties are organizing engineering Republican and Democratic clubs. They are not connected with the association in any way except that membership in the political clubs is largely made up of members of A. A. E. Members of the association will be allowed to belong to whichever one of these two clubs they wish, and if they like may organize clubs for other political parties.

The Baltimore Chapter of the American Association of Engineers has secured an option on a four-story brick residence at 16 West Chase St., to be used as a clubhouse for the chapter. Stock subscriptions are being taken in a corporation to purchase the property. The purchase price is $40,000 in fee. The chapter plans to occupy the second floor and rent the third and fourth floors to members or others who desire bachelor quarters. The first floor will be occupied by offices. The St. Louis Chapter has had similar but more comprehensive plans in mind for the last six months, but they have not been worked out. The St. Louis plan would not only furnish living quarters for the bachelor members, but would utilize much of the space in its building for a graduate school for older engineers and elementary courses for younger members. It is planned to purchase a building containing a library, lounging room, office, music room, billiard room, assembly room and several committee and class rooms.

Business Items

The Krypton (Ky.) Light and Power Co. has been organized by G. W. Humphres, L. E. Wooten and others with a capital of $25,000.

Warren Webster & Co., of Camden, N. J., have established a branch office at 15 East Fayette St., Baltimore, Md. Louis G. Vance is in charge of the office as Baltimore district manager.

The American Engineering Co., of Philadelphia, has opened a new office in Cincinnati for the purpose of extending Taylor Stoker representation and service. M. M. Masson is in charge of this office at 207 Neave Building.

Westinghouse Church Kerr and Co., Inc., and Dwight P. Robinson and Co., Inc., have announced their consolidation under the name of Dwight P. Robinson and Co., Inc. Carl C. Thomas has been appointed Western representative of the new organization. His office is in Los Angeles, Cal.

Trade Catalogs

The Smith Gas Engineering Co. Dayton, Ohio, has issued an advance bulletin describing the latest addition to its line of gas producers. The new gas producer is improved in design, and is made in sizes to handle from 800 to 3,000 lb. of coal per hour.

The Sprague Electric Works of the General Electric Co., New York City, is sending out bulletins of its electric hoists, which are built with capacities of from one quarter of a ton to six tons. The bulletins contain specifications and photographs of typical installations.

Carbon Electrode is the title of a new 18-page catalog just published by the National Carbon Co., Inc., New York. The purpose of the booklet is to place in the hands of those interested in electric-furnace operation suggestions relative to the handling, storage and use of carbon electrodes. The process of manufacture of electrodes by this company is also described. A copy of this booklet can be obtained on request.

The Technical Products Co., dealer in new and used equipment, the latter comprising large purchases from Government munitions plants, has recently issued an attractive folder entitled "The A B C's of Refrigeration," describing under the caption of "The Technical Way," the high-speed vertical single-acting ring-plate valve compressors which it is handling.

"Defend Your Steam," is the title of an attractive book by Austin Bolam, published by the Magnesia Association of America, 721 Bulletin Bldg., Philadelphia, Pa. This book presents the results of four years of original research work by the Magnesia Association of America and the Mellon Institute of Industrial Research. Its eighty pages cover exhaustively every phase of the subject of heat and fuel saving and are profusely illustrated with interesting photographs showing the use of 85 per cent Magnesia pipe and boiler coverings in plants of every kind. The results of tests, experiments and actual experience are given, and tables and data are added for the use of engineers and architects in the preparation of specifications for heat insulation.

New Construction

PROPOSED WORK

Mass., Everett—The Boston Elevated Rwy. Co., 108 Massachusetts Ave., Boston, is having plans prepared for several car repair shops including a steam heating system, here. About $3,000,000. Dwight P. Robinson, 125 East 46th St., New York City, Archt. and Engr.

Mass., Fall River—H. K. Barrows, Archt. and Engr., 6 Beacon St., Boston, is preparing plans for a 35 x 40 ft. municipal pumping station and concrete dam at Watuppa Pond, here. About $150,000.

Mass., Lynn — Goodman & Gordan, Andrew St., plans to build a theater building at Andrew St. and Central Ave. About $500,000. Architect not selected.

Mass., Swampscott (Lynn P. O.)—The Sherburne, Inc., 1 Beacon St., Boston, will soon award the contract for a 3 story theatre building, etc., including a steam heating system, on Main St. here. About $800,000. C. T. McFarland, 162 Newbury St., Boston, Archt.

R. I., Providence—The City will soon award the contracts for a 3 story, 71 x 183 ft. school on Arthur Avenue and the installation of a steam heating system in same. About $500,000. Comnr. of Pub. Bldgs., Archt. and Engr.

N. Y., Buffalo—Wilson Brauer, 265 Hoyt St., is in the market for one 1-hp., 25-cycle, 110-120 volt motor.

N. Y., New York—The Thompson-Starrett Co., 49 Wall St., is in the market for refrigeration machinery for new Providence Biltmore Hotel at Providence, R. I.

N. Y., Rochester — Loews' Enterprises, 1493 B'way, New York City, plans to build a theater here, including steam heating system. About $400,000. T. W. Lamb, 644 8th Ave., New York City, Archt. and Engr.

N. J., Trenton—The Crescent Insulated Wire Co., Olden and Taylor Sts., is having plans prepared for a 1 story, 65 x 100 ft. boiler house. About $15,000. J. O. Hunt, 114 North Montgomery St., Archt.

Pa., Riddlesburg—The Broad Top Powers Co. plans to build a power house. F. R. Weller, Hibbs Bldg., Wash., D C., Archt.

Pa., Williamsport—The Williamsport Hotel Co., c/o W. L. Stoddart, Archt. and Engr., 9 East 40th St., New York City, is having plans prepared for a hotel building including a steam heating system, here. About $1,000,000.

Md., Baltimore—C. L. Reeder, Engr., Park Ave. and Saratoga St., has been engaged to prepare plans for a new heating plant at the City Jail, Madison and Buren Sts.

Md., Catonsville (Baltimore P. O.)—The General German Orphan Asylum, 224-242 Aisquith St., Baltimore, is having plans prepared for several 1 and 2 story asylum buildings including a central power and heating plant on Bloomsburg Ave., here. About $150,000. W. M. Gieske, 65 Gunther Bldg., Baltimore, Archt.

D. C., Washington—The General Pur. Officer of the Panama Canal, will receive bids until Oct. 26 for furnishing at Cristobal or Balboa, Canal Zone, Isthmus of Panama, centrifugal and duplex pumps, motors, etc.

D. C., Washington—The United States Engineer, 305 Southern Bldg., will receive bids until Nov. 10 for furnishing and delivering electrically driven centrifugal pumps, motor generator sets, transformers and switchboards.

Va., Ashland—The Ashland Ice Co. is in the market for a new or used gas engine and gas producer, Rathburne Jones preferred. C. Boshen, Pur. Agt.

S. C., Ware Shoals—The Ware Shoals Mfg. Co. plans to build several buildings including an ice plant, etc. Jackson & Moreland, 387 Washington St., Boston, Mass., Engrs.

Ga., Atlanta—R. S. Pringle, Archts. and Engrs., Empire Bldg., will soon award the contract for a bank including a steam heating system for the Fulton National Bank. About $300,000.

Ga., Columbus—The Construction Division, War Dept., Wash., D. C., plans to build a refrigeration plant at Camp Bennings, here.

Ala., Woodward—The Woodward Iron Co. is in the market for one 100-hp. kerosene engine or semi-Deisel engine to drive mine fan of 230 r.p.m. (new or used). J. H. Leonard, Pur. Agt.

O., Akron—Peoples' Savings & Trust Co., Main and Exchange Sts., is havng plans prepared for a bank and office building including a steam heating system. About $500,000. John B. Day, 1265 Bway, New York City, Archt. and Engr.

O., Canton—The Bd. Educ. received bid for the installation of a heating system in the proposed 3 story, 135 x 160 ft. school on Belden Ave. from the Witters Co., at $42,600.

O., Cleveland—F. M. Drew and W. T. Campbell, Euclid Ave., plan to build a 20 story theater and office building including steam heating system at East 18th St. and Euclid Ave. About $5,000,000.

O., Cleveland—The Glenville Hospital, 701 Parkwood Drive, is having plans prepared for a 2 story, 40 x 50 ft. addition to the boiler and laundry building including the installation of one 100-hp. boiler. About $40,000. Harlen E. Shimmer, 2031 Euclid Ave., Archt., H. M. Benson, 701 Parkwood Drive, Engr.

O., Cleveland—The Andrew Teller Co., Leader-News Bldg., plans to build a 10 story office building including steam heating system. About $1,000,000.

O., Clintonville—The Bd. Educ., Columbus, is having plans prepared for a 2 story, 100 x 200 ft. grade school including a steam heating plant on North High Street, here. D. Riebel & Sons, New First National Bank Bldg., Columbus, Archts.

Ind., Terre Haute—Hoggson Bros., Archts. and Engrs., 485 5th Ave., New York City, are preparing preliminary plans for a 12 story bank and office building including steam heating system, here, for the Citizen Trust Co., 612 Wabash Ave. About $500,000.

Ill., Chicago—The Kroeschell Bros. Co., 460 West Erie St., is having plans prepared for a 1 and 2 story, 220 x 388 ft. ice-machine factory including a steam heating system, and a power plant on Diversey St. About $800,000. Davidson & Weiss, 53 West Jackson Boulevard, Archt., Neiler Rich & Co., 431 South Dearborn St., Electrical Engrs.

Wis., Jefferson—The St. Coletta Convent Assn. will soon receive bids for a 3 story, 60 x 260 ft. addition to convent and chapel buildings including a steam heating plant on Main St. About $260,000. E. Breilmaier & Sons Co., 432 Bway., Milwaukee, Archts.

Wis., Milwaukee—The Bd. of Industrial Educ., 62 Mason St., will soon award the contract for the foundation of a 7 story, 145 x 268 ft. school on 6th and Prairie Sts. About $1,000,000. Van Ryn & Gelleke, Caswell Blk., Archts. and Engrs.

Wis., Templeton—The Mammoth Springs Canning Co., c/o E. A. Kraemer, Rockfield, will soon award the contract for furnishing 4 boilers, necessary pumps, pipe, belting, etc., for new factory, here.

Iowa, Cedar Rapids—The Bd. Educ., K. Mategil, Secy., will soon receive bids for a 3 story, 124 x 204 ft. junior high school including a steam heating system. About $400,000. Rugh & Zalesky, 811 Securities Bldg., Archts.

Minn., Chisholm—The Bd. Educ. plans to build a 3 story, 150 x 225 ft. vocational school including a steam heating system at 3rd Ave. and Chestnut St. About $250,000. Archt. not selected.

Minn., Currie—The City voted $13,000 bonds for a municipal light plant.

Minn., Owatonna—The City Council plans an electon soon to vote on bonds for a light, power, heating and gas plant.

Mo., St. Louis—The Syndicate, c/o I. A. Hedges, Cupples Station, is having tentative plans prepared for a 3 story, 130 x 250 ft. film exchange office building at Olive and Beaumont Sts. About $500,000. Preston J. Bradshaw, International Life Bldg., Archt.

Tex., Dallas—Arthur Marshall, Oklahoma City, Okla., is having plans prepared for a 2 story ice cream factory and milk handling station, here, including a cold storage house and electrically driven equipment. About $100,000.

Tex., Denison—Eric E. Hall, Archt., 123 West Madison St., Chicago, Ill., is preparing preliminary plans for a 5 story, 150 x 150 ft. hotel including a steam heating system, at Woodard and Burnett Sts., here. About $400,000. Owner's name withheld.

Tex., Terrell—The Chmn. of the City Commission will receive bids until Oct. 25 for two 5-in., 2-stage centrifugal pumps 500, 600, 700, 800 gal. per minute capacity against a 200-ft. head, direct connected to 2- or 3-phase, 60-cycle, 2,200-volt electric motors; installation to be made complete, with all wiring, switches and transformers necessary to make currents interchangeable as between 2- or 3-phase. Also as counter proposition, two 5-in., 3-stage centrifugal pumps 500, 600, 700, 800 gal. per minute capacity against a 200-ft. head, belted to two or three 75-hp. oil engines of high compression, ignition type. Bids will also be received for 3 miles of power line.

Ore., Portland—Emanuel Hospital, 212 Stanton St., is having plans prepared for a 6 story hospital, 4 story nurses' home, and a power house at Commercial and Stanton Sts. About $300,000. Ernest Kroner, 301 Spaulding Bldg., Archt.

Que., Coaticook—The Corp. of Coaticook plans to build a power house and dam to include one 600-hp. waterwheel and governor. About $65,000. E. E. Akhurst, Supt.

Ont., London—R. M. McElheran, Secy. of Bd. Educ., Dundas St., will receive bids early in November for a collegiate institute on Dufferin Ave. About $750,000. L. E. Carrothers, c/o Bd. Educ., Archt.

Ont., Wardsville—The Town Council plans to build an electric lighting and power distribution plant. About $15,000. Engrs. from the Ontario Hydro-Power Comn., University Ave., in charge of work.

CONTRACTS AWARDED

Me., Lisbon Falls—The Worumbo Mfg. Co. has awarded the contract for a 2 story 53 x 93 ft. boiler house and a 50 x 63 ft. turbine house to the Turner Constr. Co., 178 Tremont St., Boston, at $50,000.

Mass., Boston—The Natl. Shawmut Bank, 40 Water St., has awarded the contract for an 8 story bank and office building addition including a steam heating system on Devonshire St., to L. P. Soule & Son Co., 80 Boylston St., Boston, at $1,000,000.

Mass., Norwood—The Hollister Mills, Lenox Ave., has awarded the contract for a 2 story, 134 x 282 ft. textile factory and a 50 x 70 ft. boiler house to C. A. Batson, 26 Arlington St., Brockton. About $300,000. Noted September 14.

N. Y., Buffalo—The Amer. Car & Fdry. Co., 370 Babcock St., has awarded the contract for a 1 story, 43 x 100 x 43 ft. boiler house to J. W. Cowper, Fidelity Bldg., at $50,000. Noted July 13.

N. Y., Coney Island (Brooklyn P. O.)—Wm. Fox Associates, 715 Bway,. New York City, have awarded the contract for a theater building and bath house including a steam heating system at 20 Surf Ave., to Fred T. Ley, 19 West 44th St., New York City, at $325,000.

Pa., Harrisburg—The Bd. of Comnrs. of Public Grounds and Buildings, T. W. Templeton, Supt., has awarded the contract for the installation of a heating system for three temporary office buildings for the State to Eugene Fogarty, 1121 North Front St., at $20,011.

Pa., Philadelphia—The Daniels Motor Co., 3rd St., Reading, has awarded the contract for a 1 and 2 story, 40 x 100 ft., 80 x 125 ft., 80 x 485 ft., office, manufacturing and assembling plant at Westmoreland St. and Huntington Park, here, to Wm. Steele & Sons Co., 16th and Arch Sts. A steam heating system will be installed in same.

Md., Baltimore—The Bd. of Awards has awarded contracts for repairing the heating plant at Bayview Hospital, at $14,753 and for running two new heating lines from Bayview to Sydenham Hospitals, at $7,531.25, to H. A. Kries & Sons Co., 6-8 West Lombard St.

Mich., Detroit—The Bd. Educ., 50 Broadway, has awarded contracts both for the installaton of a heating, plumbing and ventilating system in the Thirkell School addition, at $58,763 and in the Lincoln School addition, at $23,745, to O'Connor Bros., 179 Shelby St.

Mo., Kansas City—The Corn Products Refining Co., 17 Battery Place, New York City, will build a plant including a steam heating system, here. About $500,000. Work will be done by day labor.

Tex., Gonzales—The F. E. Shuler Grain Co. will build a 2 story grain elevator plant including one 40-hp. steam engine. About $50,000. Work will be done by day labor.

Tex., Wichita Falls—The State Bd. of Control, Austin, has awarded the contract for installing a complete steam heating system in the Northwest Texas Insane Asylum, here, to Kinnison Bros., 311-313 North Austin St., Dallas, at $69,860. Noted Sept. 28.

Ont., Midland—The Copeland Flour Mills, Midland Ave., has awarded the contract for a 7 story, 100 x 170 ft. flour mill including the installation of a steam heating plant to McFarlane, Pratt Hanley Co., Waterfront St., at $365,000.

Mass., Brookline—John J. Smith, Archt., 1106 Old South Bldg., Boston, will build two apartment hotels, here, one an 8 story, 136 x 254 ft. building at Beacon and Kent Sts., about $1,250,000, and the other an 8 story, 120 x 238 ft. building at Prang St. and Huntington Ave., about $1,000,000. Contracts for the installation of steam heating systems will be sub-let. Owners' names withheld. Work will be done by day labor.

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